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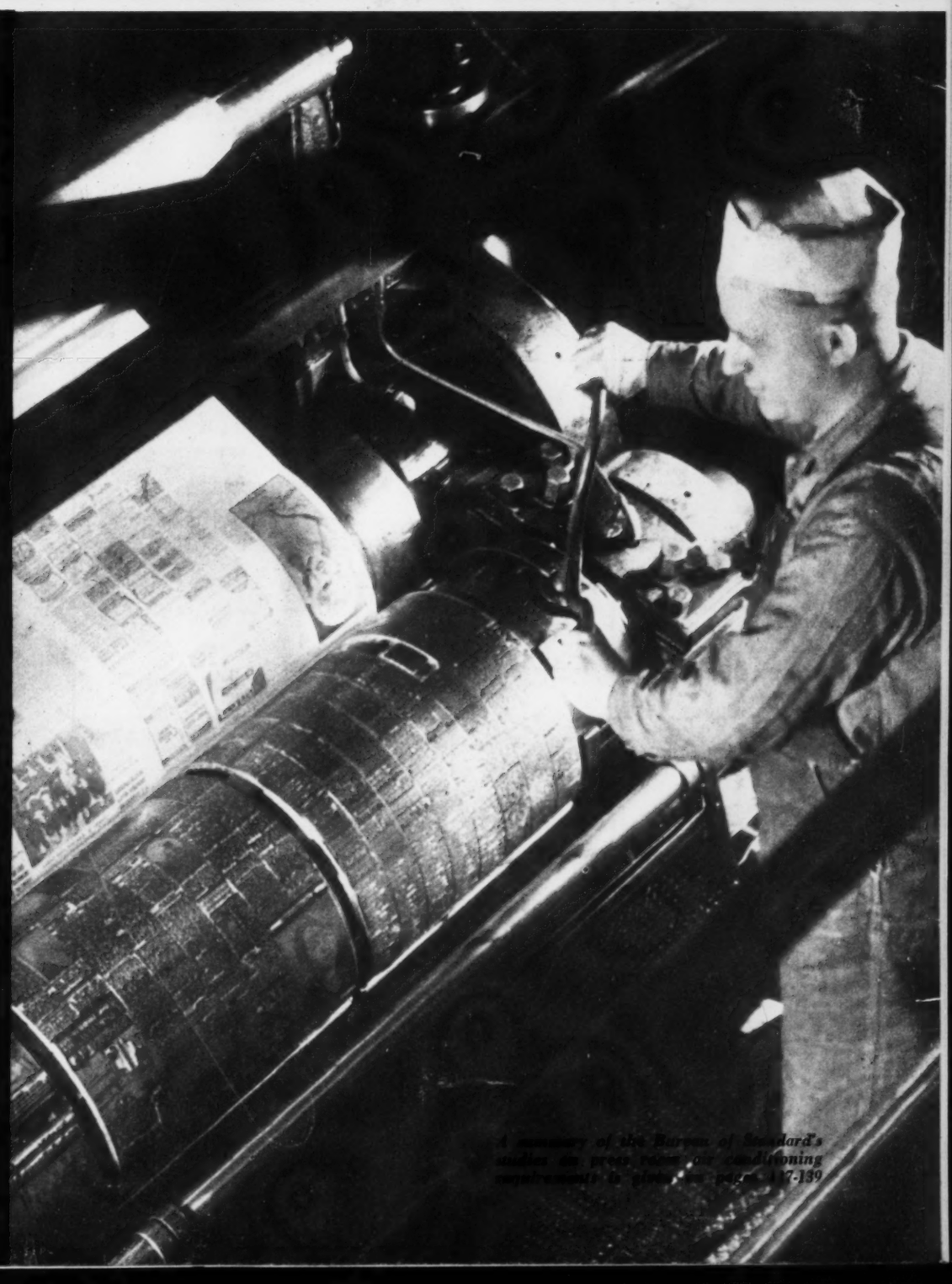
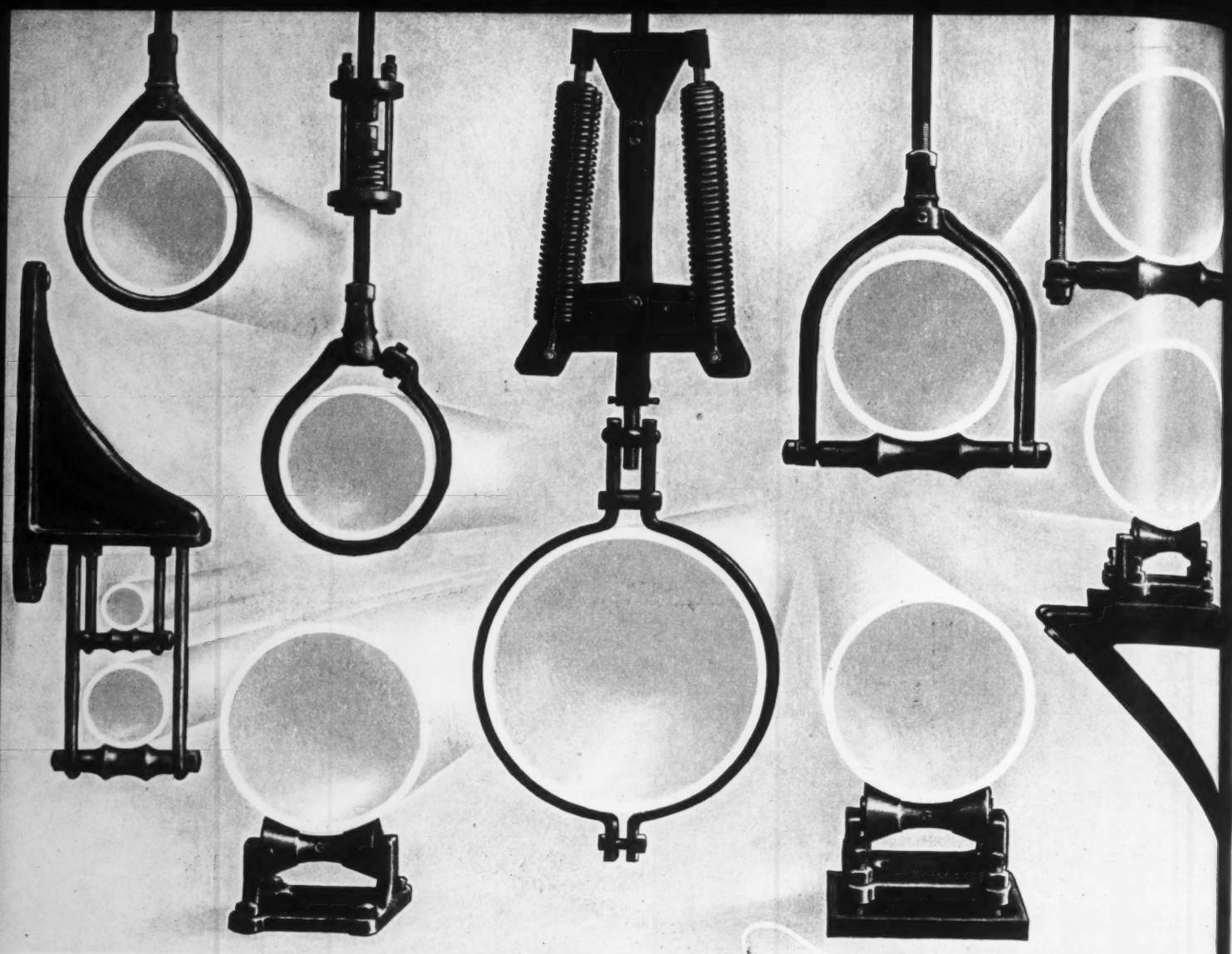
Heating · Piping and Air Conditioning



A summary of the Bureau of Standard's studies on green room air conditioning requirements is given on page 117-139



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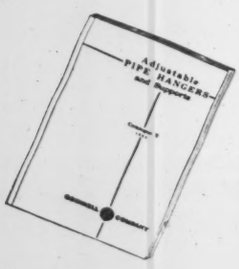

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FABRICATED PIPING AND ALLIED PRODUCTS TO GRINNELL LABORATORY STANDA

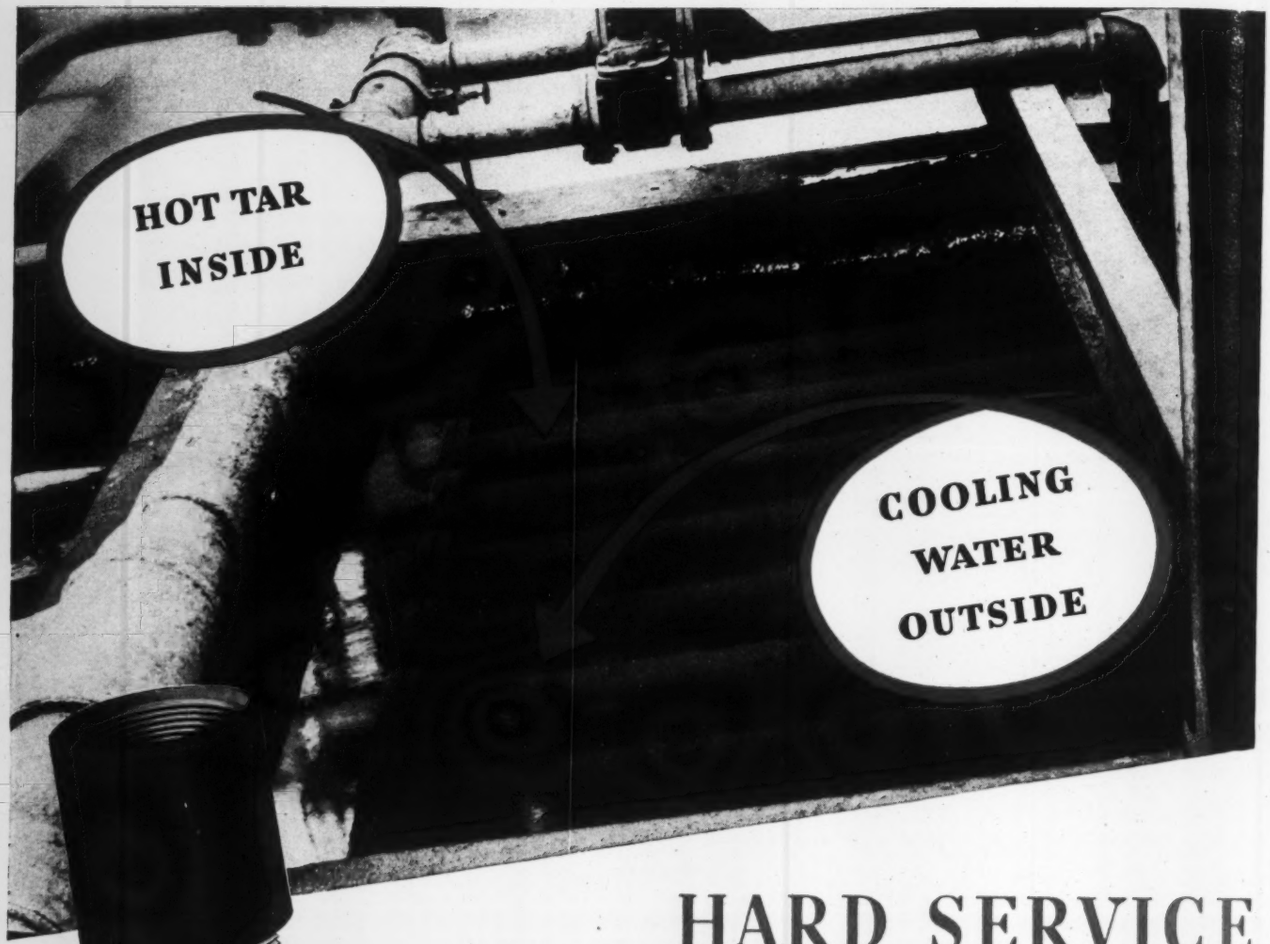
THE EDITOR'S PAGE

ARTICLES in this issue cover numerous phases of the subject of heating, piping and air conditioning in industry and large buildings. . . . Among them are papers on air conditioning requirements of printing plants, estimating piping, a gas fired boiler plant for a hotel and its control, solving air conditioning problems, the practical piping problem of selecting a pump to evacuate a tank. . . . In the A. S. H. V. E. Journal Section appear the Proceedings of the Society's annual meeting, a report of the Fourth International Heating & Ventilating Exposition.

Large scale housing projects which have been accepted for insurance by the Federal Housing Administration reached a new total of $33,200,234 last month, according to the FHA. . . . Chicago's coldest thirty-day period since the government began keeping weather records in 1871 ended last month; average daily temperature was 6.2 F, with zero temperatures or below on twenty of the thirty days. The previous record was established in 1895. . . . William Lescaze, who was associated in the design of the completely air conditioned 33-story Philadelphia Savings Fund Society building, described in the August, 1933, H. P. & A. C., has designed one of the units for the Purdue Housing Research Campus. . . . Much has been accomplished in standardizing widths, heights, lengths, and ratings of copper convectors which has simplified their application for the architect, engineer, and contractor, according to A. A. Ahlff of Chase Brass & Copper Co., recently elected president of the Convector Manufacturers Association. . . . Following its current consumer advertising campaign based on the theme "be modern with air conditioning," Minneapolis-Honeywell Regulator Co. will stress the fact that air conditioning will pay big dividends in health and comfort, will reward hotel, apartment and theater owners with increased patronage and satisfied customers, improves plant processing and employee efficiency in industry.

Many meetings and conferences on heating, piping or air conditioning are listed under "Conventions and Expositions" this month. . . . Dr. Arthur Cutts Willard, President of the University of Illinois, heads the program for the air conditioning conference to be held at Urbana May 4 and 5. Other speakers are F. C. Houghten, Prof. A. P. Kratz, Prof. P. E. Mohn, S. Konzo, Dr. William H. Welker, Prof. W. H. Severns, Prof. F. B. Rowley of the University of Minnesota, E. L. Broderick, Prof. H. J. Macintire, and M. K. Fahnestock. Comfort conditions and physiological factors involved in air conditioning, physical factors affecting comfort, heating systems, fuel saving, health problems and benefits created by air conditioning, estimating humidification requirements, air filters, estimating the cooling load, and research at the U. of I. will be discussed. . . . Fundamentals, design, standards and requirements, operating costs, research and other topics are scheduled for attention at Iowa State's air conditioning and heating conference at Ames the 25th, 26th and 27th of this month. Open to everyone interested in air conditioning, the program is expected to be of particular value to architects, contractors, heating and refrigerating engineers, and similar groups. . . . Among the papers scheduled for the Power Engineering Conference at the Palmer House, Chicago, in April are "Refrigeration," "Power Piping and Welding," "Fuel Economy and Controls," "Power Transmission to Machinery" and several others of interest to H. P. & A. C. readers. . . . A session on air conditioning is programmed for the International Congress of Refrigeration in Holland next June.

March, 1936



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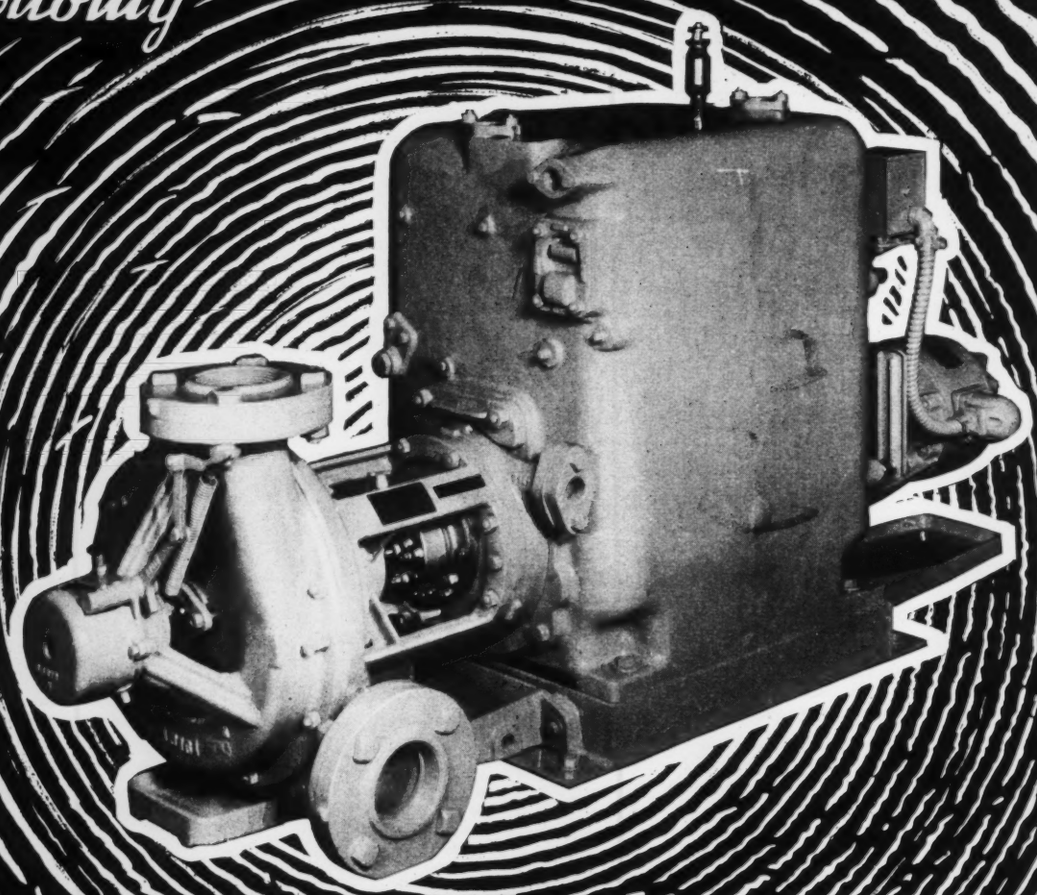
Centralized Heating Economy



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Heating · Piping and Air Conditioning

Vol. 8, No. 3 • *March, 1936*

Control Matches Boiler Operation to Hotel's Heat and Steam Requirements

FLEXIBILITY of operation is particularly important to heating efficiency and economy in a hotel, as steam is needed at various pressures for various services, and steam requirements fluctuate widely because of the factors of occupancy, banquets, conventions, the weather, time of day, whether or not the laundry is operating, and so on. The new gas fired boiler plant for the 250 room Hotel Orlando, Decatur, Ill., placed in operation the first of this year, has been designed to provide this necessary flexibility and incorporates unusual features of control and operation.

The Orlando formerly bought steam from an adjoining office building, so that space was not available in the hotel for the boiler room. The problem was solved by an underground boiler room in the interior court area, space also being provided for the future installation of refrigerating equipment as it is expected to air condition the cafes, bar, cocktail lounge, banquet hall, barber shop, and other public spaces. Excavation was started last fall on November 10, and the plant went into operation December 30, just in time to take over the load when the contract for purchase of steam was terminated.

Typical Day's Operation

The installation is particularly interesting because the boilers operate themselves, practically, and the design allows for supplying different quantities of steam at different pressures during the day and night as required by the heating system, the kitchen and the laundry. A description of a typical day's operation will serve as a background for the explanation of the details of the job to follow.

At 5:00 a. m. the night porter "turns on" the high pressure boiler (which was shut off at 11:00 p. m.) to supply steam at the lower of two pressure settings for the kitchen. At this setting a modulating gas valve and an air control damper operate to control steam pressure between 10 and 14 lb per sq in., modulating between these limits. At 7 a. m. the laundry man puts this boiler on the high setting, and during operation of the laundry steam is furnished by this boiler at a pressure between 80 and 90 lb per sq in., modulating between these limits. At 4 p. m. the laundry man puts the boiler back on the lower setting, on which it runs until the night porter shuts the boiler down at 11 p. m., which leaves enough steam available to supply kitchen requirements until the kitchen closes at midnight.

The two low pressure boilers (only one operating at a time, except when the outdoor temperature drops below minus 6 F) are controlled in the same manner as is the high pressure boiler, and supply heating steam between ½ and 2 lb, modulating between these limits. All hot water heating is done by the low pressure boilers during the winter; in summer, hot water is heated by the high pressure boiler, which is, of course, the only one in operation then. An average of 10,000 gallons of domestic hot water are heated per day through a temperature range from 40 to 160 F.

Boiler Plant and Control

The high pressure firebox boiler, seen at the right of Fig. 1, has a rated capacity of 4860 sq ft and each of the two low pressure firebox boilers is rated at 10,330 sq ft. Each is fired by a specially designed gas burner; the gas used has a heat unit content of 1040 Btu, and the cost is 38c per 1000 cu ft for the first million cubic feet used per month, 25c for the second million, and 20c for the third million. Table 1 shows the cu ft of gas used per day for the first month of operation, the degree days, and whether or not steam was supplied the laundry each day.

A hotel imposes severe requirements upon its heating plant because of the several services for which steam at different pressures is needed, and the numerous factors which affect steam consumption.... Described here is the gas fired installation for the 250 room Hotel Orlando, Decatur, Ill., where, by means of the method of modulating control employed, the boilers are operated in close harmony with load requirements. Steam at the proper pressures for laundry, kitchen and heating is supplied almost automatically

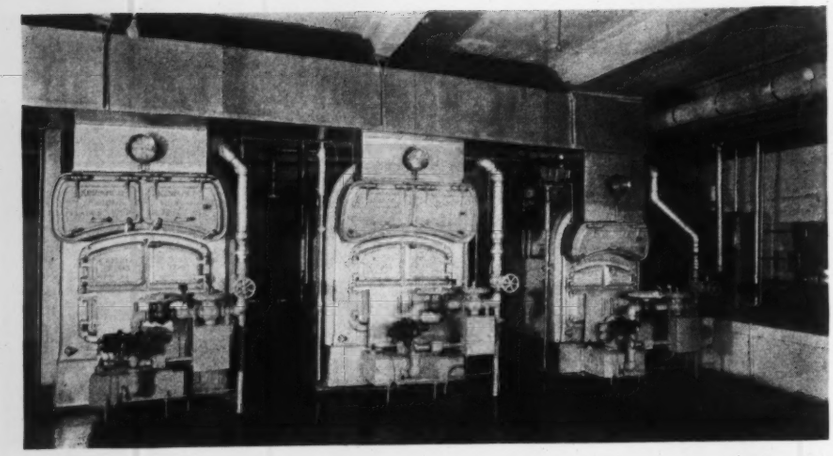


Fig. 1—Spick and span is the boiler room at the 250 room Hotel Orlando, Decatur, Ill. The high pressure gas fired boiler at the right supplies kitchen and laundry steam requirements, and the two low pressure gas fired boilers furnish steam for building heating. Space is available in the boiler room for future installation of air conditioning equipment

Constant draft irrespective of temperatures, winds, or loads on the boilers is maintained by an automatic draft regulator.

Feature of the job is the manner in which the gas and air for combustion are controlled to match the load requirements; the control is not on and off but the gas and air supplied to the burners is continuously modulated depending upon the steam pressure. A close-up of one of the control valves is shown as Fig. 2. It may be seen that the gas valve and the shutters for air control are interconnected to maintain the gas and air supply as nearly as possible at the ideal ratio for all loads. That this method of control has achieved its object in maintaining high efficiencies over a wide range of load variations is indicated by the stack loss curves and accompanying data.

Jack H. Powers of Decatur designed and installed the job, and his cooperation in the preparation of this description is acknowledged.

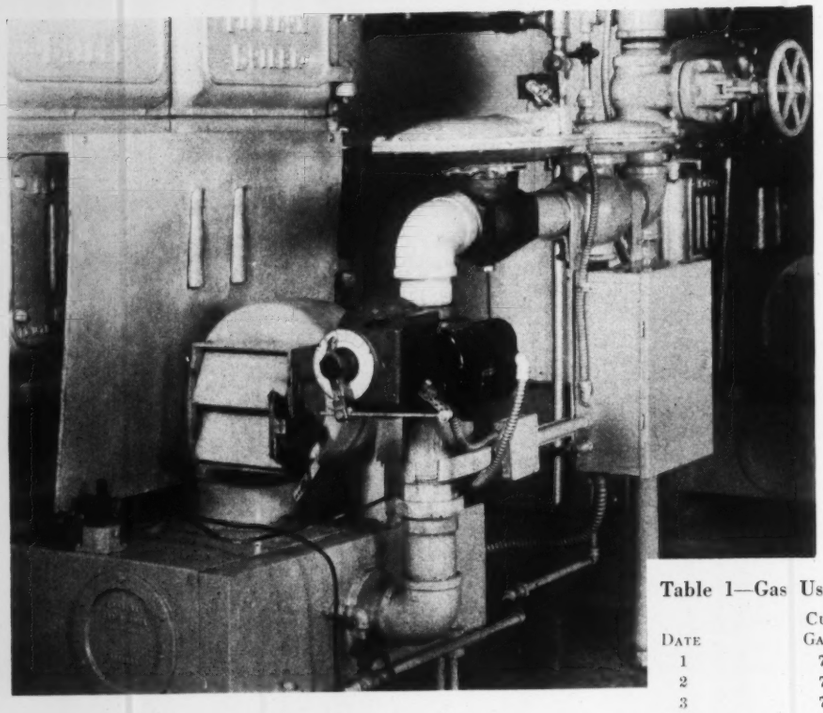
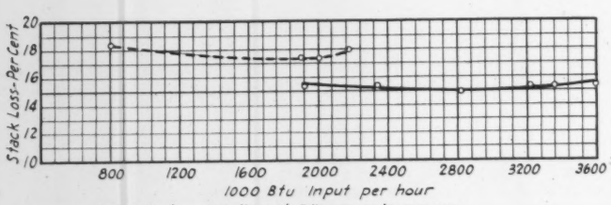


Fig. 2—Close-up of the modulating gas control valve and interconnected air control shutters which permit matching the fuel consumption to load requirements



—— No.1 & 2 Boilers operating at 5 lb per sq in. pressure.
---- No.3 Boiler operating at 90 lb per sq in. pressure.
Boilers fired with Natural Gas having a heating value of 1040 Btu per cu ft and an ultimate CO_2 of 11.7%

Boiler Number	Throttle Position	Stack Temp, F	CO_2 Per Cent	O_2 Per Cent	Btu Input Per Hour	Stack Loss Per Cent
No. 1	¼	275	8.2	6.2	2,340,000	15.4
	½	290	9.6	3.8	3,220,000	15.4
Low	⅜	300	9.6	3.8	3,360,000	15.4
Pressure	Open	305	9.0	4.9	3,540,000	16.0
No. 2	¼	250	7.4	7.8	1,920,000	15.4
Low	½	280	9.2	4.5	2,820,000	15.0
	¾	290	9.4	4.0	3,360,000	15.4
Pressure	Open	295	10.0	3.4	3,540,000	15.4
No. 3	¼	375	8.6	5.8	800,000	18.3
High	½	385	10.0	3.0	1,900,000	17.4
	¾	390	10.0	3.0	2,000,000	17.4
Pressure	Open	395	10.0	3.0	2,180,000	18.0

Fig. 3—Chart showing percentage of stack losses for the Hotel Orlando boilers

Table 1—Gas Used at 250-Room Hotel Orlando, January, 1936

Date	Cu Ft of Gas Used	Degree Days	Laundry Operation
1	75,900	36.75	No Laundry
2	76,600	31.50	No Laundry
3	76,700	28.75	Laundry
4	71,500	33.00	Laundry ½ day
5	66,100	32.75	No Laundry
6	75,500	28.50	Laundry
7	79,700	30.25	Laundry
8	82,200	30.75	Laundry
9	80,300	31.25	Laundry
10	79,100	32.75	Laundry
11	68,100	27.77	No Laundry
12	63,500	20.00	No Laundry
13	66,100	31.00	Laundry
14	71,900	19.00	Laundry
15	74,800	36.00	Laundry
16	80,100	36.50	Laundry
17	84,200	37.25	Laundry
18	73,800	36.00	No Laundry
19	68,500	45.25	No Laundry
20	77,500	48.50	Laundry
21	78,400	37.00	Laundry
22	91,000	59.00	Laundry
23	108,200	82.00	Laundry
24	103,500	64.25	Laundry
25	106,000	57.50	Laundry
26	85,400	63.75	No Laundry
27	90,000	36.25	Laundry
28	106,400	62.00	Laundry
29	114,300	50.75	Laundry
30	116,600	68.00	Laundry
31	113,400	64.00	Laundry
	2,605,300	1,323.00	

Note—There are 11,000 sq ft of direct radiation installed. 10,000 gallons of water per day with a temperature rise from 40 to 160 F are heated.

Bureau of Standards Studies Determine Press Room Conditioning Requirements

By C. G. Weber*

PAPER adjusts its moisture content rapidly with changes in relative humidity of the surrounding atmosphere, and all moisture content changes are accompanied by contraction or expansion of the paper. These dimension changes are responsible for wavy edges, buckled paper and poor register of prints in multicolor printing. In multicolor printing by the offset process, the different colors are usually printed separately, which means that the paper must make a separate trip through the press for each color. Quality color printing requires that all subsequent prints coincide with the first to within a half-hundreth inch, and since images 50 in. or more wide are not uncommon, the importance of keeping the dimensions of paper constant during printing may be readily appreciated. This has been the subject of study at the National Bureau of Standards.

Reaction of Paper to Humidity Variations

The dimensions of paper are affected by its hygroscopic moisture through swelling of the individual fibers, and for the ordinary range of atmospheric conditions, vary directly with the moisture content.[1] A moisture content change of but one-half of one per cent, which will result from a humidity variation of about 5 per cent in the surrounding air, will cause a distortion of 0.03 in. on a 60 in. sheet, sufficient to cause serious mis-register in many classes of work and resulting in poor quality, excessive spoilage, and loss of production. When it is considered that a fluctuation of 40 per cent in relative humidity from one day to the next is not uncommon, the importance of air conditioning to the offset lithographic industry is obvious. It is possible for a skilled printer to obtain satisfactory register under trying conditions by press manipulation, but changing dimensions interfere with quality and production to an extent that cannot be tolerated in a modern plant. Fig. 1 shows the relation of relative humidity to moisture content of typical offset papers, and Fig. 2 the relation of moisture content to the dimensions. Moisture content is influenced slightly by temperature variations, but this is not important if excessive flucuation is avoided.

Determining Proper Air Conditions

It might appear that difficulties in obtaining close register due to moisture content variations would be eliminated by maintaining constant relative humidity in the press room. However, such is not the case; the installation of equipment to control humidity and temperature to within very close limits has not always solved the paper distortion problem. In fact, paper conditioned to equilibrium with the press room atmosphere will absorb moisture and expand during printing. The absorbed moisture comes from the press, and conditions that will cause the paper to lose to the air an amount of moisture equivalent to the press moisture added during printing must be maintained for constant dimensions. To accomplish this, it has been found necessary to raise the moisture content above equilibrium with the press room humidity for the start of the first printing.

The moisture content changes during printing for papers given different conditioning treatments are shown in

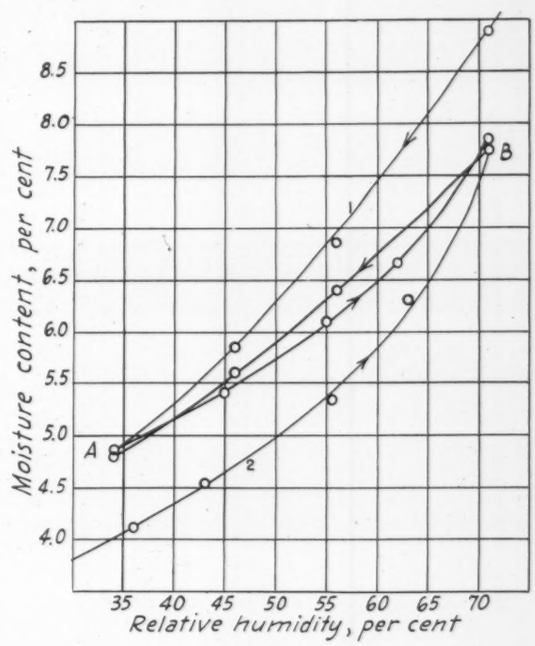


Fig. 1—Equilibrium moisture content of papers at different relative humidities. Curve *1* for desorption from saturated condition. Curve *2* for adsorption from oven-dry condition

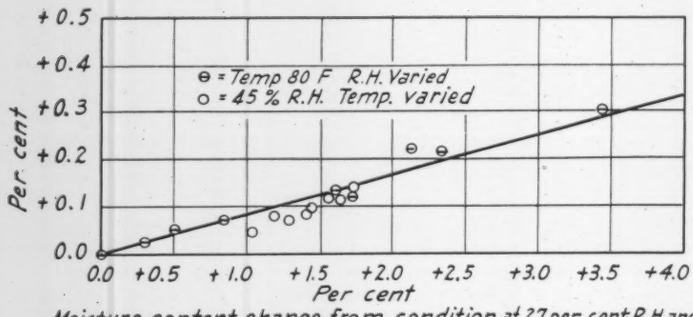
Fig. 3. Best results with respect to low moisture change have been obtained by starting the first print with the moisture content about 0.5 per cent above that corresponding with the press room air; this is a point that must be considered when planning an air conditioning installation, because unless provision is made for conditioning the paper in a room separate from the press room, and under independent control, only part of the benefits of air conditioning will be obtained.

Air Conditioning Systems

Central station plants, conditioning the air for the entire building or for the area desired within the building, are suitable for print shops, and the dew point control system, with refrigeration for dehumidifying, has been found satisfactory. With a system of this type, constant relative humidity and temperature day and

*National Bureau of Standards. Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce.

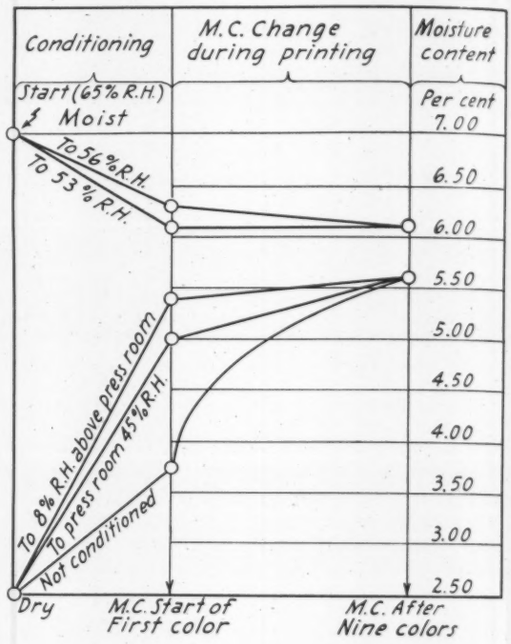
[1]Weber, C. G., and Snyder, L. W., *Bureau of Standards J. Research* 12:53 (1934).



Moisture content change from condition at 27 per cent R.H. and 80 F. Values at left are: Dimensional changes from condition at 27 per cent R.H. and 80 F

Fig. 2—Influence of moisture content variations on dimensions of lithographic papers

Fig. 3—Influence of hygrometric condition on moisture content change during multicolor printing



night throughout the year, regardless of outside weather conditions, can be maintained. However, there is no doubt that the cost of installation of this system has been so high that it has not been generally used in the average lithographic plant, and systems employing other means of dehumidification, now in the development stage, show promise of providing year around relative humidity control with lower first cost. One system employs a dehydrating agent such as silica gel for dehumidification, combined with spray humidifiers, instead of refrigeration. Humidistats are used to furnish automatic control by having the high contacts operate the dampers on the dehydrator and the low contacts the humidifiers. Another system employs salt solutions for adjusting the relative humidity of the air. Control in this system is obtained by automatic adjustment of the solution concentration.[2] It is hoped that the development of these systems will provide the small lithographic plant with suitable relative humidity control without the large initial investment required for refrigeration.

Humidification without dehumidification of any kind may be employed to give constant relative humidity during the winter, but with no means of reducing the moisture content of the air, this system is of course inoperative during humid weather. Low installation cost makes this type of equipment available for shops that cannot afford equipment for complete control. It provides adequate control for approximately 8 months of the year, and this with the possibility that a low cost dehydrating unit may be made available for use with it to provide year around control, makes this type of installation attractive to many print shops.

In selecting conditions for a printing plant, it should be remembered that the accumulation of static electric charges is greatest when the relative humidity is lowest, and at 45 per cent or above, it is never troublesome. On the other hand, it is difficult for many mills to deliver paper with moisture content high enough to facilitate paper conditioning if the humidity is maintained much above 45 per cent; hence, approximately 45 per cent relative humidity may be considered optimum, although condensation on windows may be troublesome in cold weather unless double windows are provided. Comfort and economy of operation should be the factors influencing the choice of the temperature to maintain.

Paper Should Be Conditioned

For efficient printing, paper should be conditioned before printing so that it will lie flat and keep constant moisture content during printing. Studies[3] have indicated that wavy edges, curling, and buckling are best prevented by conditioning the paper as soon as it is exposed to the room atmosphere upon opening the case. It has also been found that the moisture content remains most nearly constant during printing when it is adjusted to 0.5 per cent above that corresponding to equilibrium with the press room atmosphere. The conditioning may be accomplished by racking the paper in small lifts and blowing air around it. Conditioning machines are convenient for this purpose, but are not essential if adequate circulation of air can be provided by other means. The proper moisture content will be assured if the paper is conditioned in a room with relative humidity 5 to 8 per cent above that of the press room.

The sword type of paper hygroscope[4] is a convenient tool for determining the hygrometric condition of paper with respect to the surrounding air. The paper will be best prepared for multicolor printing when the sword indicates that it is in equilibrium with the conditioning room air at 5 to 8 per cent above the press room, and "wet" with respect to the press room air by a sword reading equivalent to 0.5 per cent moisture content. An installation that does not provide means of adjusting the moisture content of the paper to approximately 0.5 per cent above equilibrium with the press room condition is not properly adapted to an offset lithographic plant.

Some plants now have air conditioned press rooms but do not have facilities for conditioning paper to the proper moisture content. Where it is not possible to provide an independent paper conditioning room the situation may be corrected by requiring the paper manufacturer to deliver paper with the correct moisture content.

[2] *Ind. and Eng. Chem.*, Vol. 27, No. 8:879 (Aug. 1935).

[3] Weber, C. G., and Cobb, R. M., *Bureau of Standards J. of Research*, 9:427 (1932).

[4] The Paper Hygroscope, *Litho. Tech. Foundation*, 220 E. 42nd St., New York, N. Y.

While the finishing of lithographic papers with sufficiently high moisture content involves manufacturing difficulties, the paper can be adjusted at the mill by exposing to the proper humidity or by the use of special moistening devices after calendering. If properly protected in the cases by waterproof wrappers, the moisture content will remain practically constant during shipment and storage.

Instruments Needed to Operate Air Conditioning Plants Properly

By **William A. Hanley***

TO assure best results after an air conditioning system has been finally adjusted, certain temperatures and pressures should be recorded daily during the time the equipment is in use. Recording instruments drawing a graph or curve give an unbiased record and in most cases are advisable. In some fine industrial work these may be supplemented by indicating thermometers or gauges having finer graduations than can be found on the recording instruments.

The data recorded should include (1) refrigerant temperature to and from washer; (2) water temperature to and from washer; (3) water pressure on sprays; (4) wet and dry bulb air temperatures entering washer; (5) wet and dry bulb air temperatures leaving washer; (6) static pressure of air at discharge of washer.

If some recording instruments must be sacrificed, for economy, it is recommended that Item 5 above be considered the most essential. Under any circumstances all of this information should be regularly recorded on a log sheet filed for reference. With such information available an analysis can quickly be made in case of trouble, or an impending failure can be forecast and possibly avoided.

Every instrument should be checked annually or oftener if there appears to be variation in results.

Air conditioning equipment should not be run over three or four days without entirely replacing the water in the washer. It may be necessary to replace the water oftener if very dirty air is being put through the washer, but a fresh supply should be introduced at least twice a week.

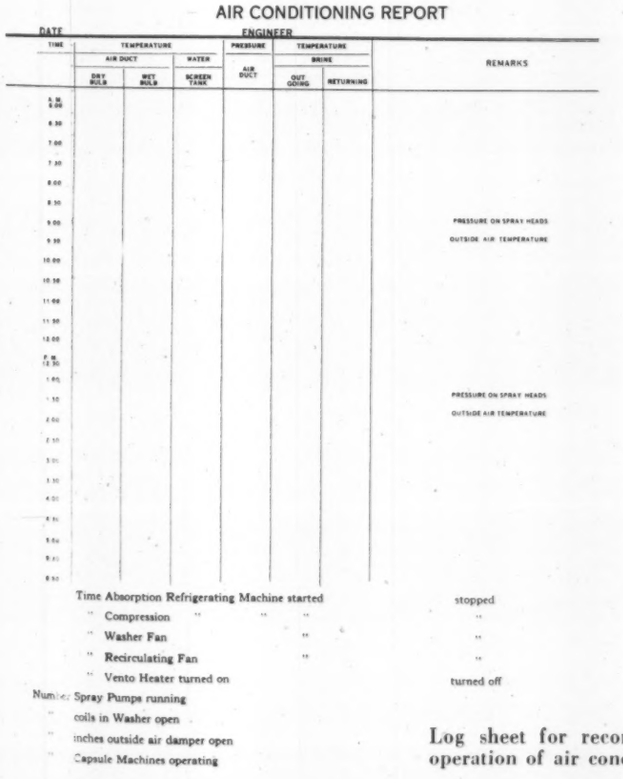
Our experience has been that the first parts of air conditioning equipment to show signs of failure are the eliminators and fan runner. These surfaces are partially wet and partially dry and therefore are subject to rapid rusting. To prevent, or at least delay, such failure it has been found good practice thoroughly to clean and paint the eliminators and fan at least once a year. This not only applies to such parts, but also to all other exposed sheet metal parts. The annual clean up should include the examination of all insulation, the cleaning up, dismantling and overhauling of the motors and pumps and the cleaning of the ducts. Regardless of the design, certain dirt particles will go through any washer, and any system used continually will be found to contain much dirt at the end of a year's service.

Many failures are caused, and some at very inopportune times, because of rubber gaskets or rubber diaphragms that have lost their elasticity or become thin or worn in spots. It is good practice to change every rubber gasket and rubber diaphragm at least once every three years.

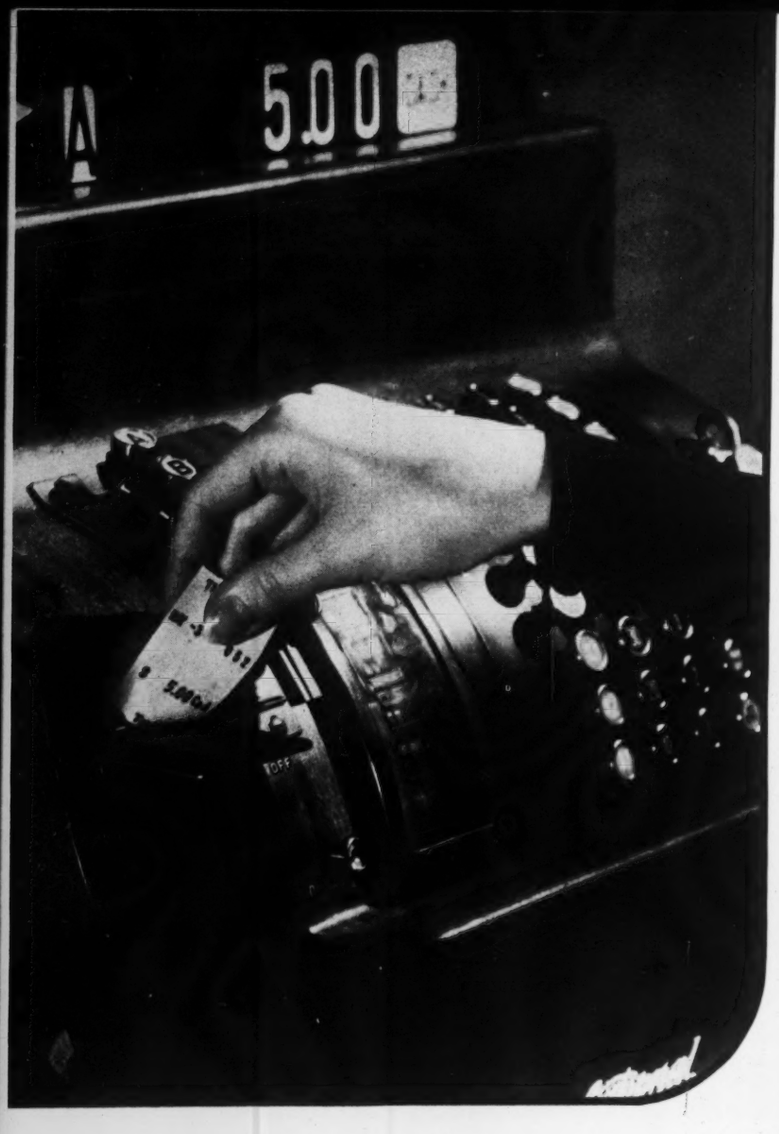
Unsatisfactory operation of air conditioning plants may come about through many causes. Among the most common causes, however, are overloading of plant due to air infiltration in warm weather, dirty spray heads resulting in low rate of heat transfer, and clogged air filters resulting in retarded circulation. Other causes are insufficient refrigeration equipment in the initial installation, insufficient water to condensers, or accumulated muck in condensers.

Air conditioning plants properly operated and maintained will operate for years without any failure and may be considered as reliable as any other plant or building equipment.

*Director of Engineering, Eli Lilly & Co., Indianapolis, Ind. Member of Board of Consulting and Contributing Editors.



Log sheet for recording data on operation of air conditioning plant



"What Air Conditioning Did for My Business"

Air conditioning has proved itself to be a business builder, the experiences of many owners show

SO WELL has air conditioning proved itself an aid—and a necessity—to business, it is difficult to think of a type of commercial establishment where its possibilities do not deserve investigation. Unexpected advantages frequently are found to have been obtained in addition to the expected results which have been the basis for an investment in air conditioning equipment. For instance, a jewelry store reported that air conditioning prevented tarnishing of silver and contributed to keeping pearls in better condition, in addition to providing comfort for customers and employees. A department store found, after installation of air conditioning, that revenue from pay toilets averaged $70 per week during the summer instead of the previous $30 to $35!

Although specific figures in dollars and cents are quite often difficult to obtain because of the many factors involved, and lack of records which are truly comparable before and after air conditioning is installed, many an owner can cite experiences which prove his investment to be a paying proposition. For instance: (1) "Science has been very kind to the candy business in inventing air conditioning machines," according to A. S. Kanelos, president of Andes Candies, Chicago candy shop chain. "Candies kept in an air conditioned store are fresh, glossy, and appetizing—a customer walking into an air conditioned candy shop is immediately induced into the mood to make purchases, due to the comfortable environment and the attractiveness of the candy. Also, the sales ladies are never fagged out from the heat, and are able to approach customers in the proper manner.

"Last summer we did not have to worry about candies being spoiled from the heat in our air conditioned shops," he reports, "and anyone who has gone through hot weather in the candy business can readily understand what a mental relief this is."

(2) Since their first venture into air conditioning, Schleisner & Co., Baltimore, dealing mainly in women's apparel, became a staunch advocate. They found that it not only removed the old hesitation about summer shopping, but actually encouraged shopping in summer. Moreover, advertising value and prestige was built up by air conditioning.

(3) Air conditioning brought an increase of 25 per cent in total summer business for Caplan's drug store, Harrisburg, Pa., according to the proprietor, and the store's luncheon business was boosted a full third on summer days. Some of the benefits of air conditioning cited by Mr. Caplan are a marked appreciation of it among his customers, better dispositions of his employees and consequently more courteous service by them, and better condition of candies and as a result increased candy sales. One of the leading advantages of air conditioning is its advertising value—both by word-of-mouth and as a subject for newspaper advertising and window signs. The store distributes match-books mentioning air conditioning.

(4) The air conditioning system for the warehouse of C. H. Stallman & Son, wholesale distributors of candy and tobacco, York, Pa., accomplishes more in the way of satisfactory results than merely to eliminate the discomfort of hot weather, according to George L. Stallman, Jr. With the installation of air conditioning, many "hot weather worries" vanished, among them the fact that all candy, particularly chocolate coatings, has a way

[*Concluded on page* 144]

Practical Piping Problems

How to Select a Pump for Evacuating a Tank

By **S. B. Redfield***

IN certain industries, materials to be processed are placed in a tank, a vacuum is drawn and chemicals are admitted for the purpose of impregnating the materials. Various treatments of wood products, for instance, employ this process. An important question is the length of time needed to produce the required vacuum in apparatus of a given cubic content with a vacuum pump of a given size. The converse problem arises also; namely, how large a vacuum pump will be required to evacuate the tank in a given time.

The pump must be able not only to produce a "dead end" vacuum higher than the requirements of the process, but as the dead end point means zero volumetric efficiency of the pump and zero output, the margin between the vacuum required and the dead end vacuum of the pump will have a vital influence upon the time required to reach the desired working vacuum. As the dead end is approached, the pump volumetric efficiency becomes very low and the amount of air handled exceedingly small. With a dead end equal only to the ultimate vacuum desired, the time to reach this working vacuum would be infinite, and with only a small margin, the time stretches out enormously as the vacuum gets higher. This is evident from Fig. 2, where the total elapsed time for an assumed set of conditions is plotted against vacuum reached. In this case the highest vacuum desired is within 1 in. of the barometer and the pump dead end is within ½ in. of the barometer. This is a fairly good pump for ordinary commercial purposes but the sharp upward turn of the time—vacuum curve is very marked.

For a problem, assume the tank volume or cubic content is 100 cu ft. Further, assume a vacuum pump having a piston displacement of 74 cfm and that it can pull a dead end of 29.5 in. on a 30 in. barometer; that is, it can reach within ½ in. of the barometer. Let the actual barometer in the problem be 29.6 in. and assume we wish to evacuate the tank to within 1 in. of the barometer; that is, to 28.6 in.

We can plot the curve shown in Fig. 1 for the volumetric efficiency of the pump, the air quantity being expressed at *atmospheric pressure*, and intake temperature. The high vacuum—zero volumetric end of the curve corresponding to 29.5 in. on 30 in. barometer is 29.5 30 = 98.3 per cent vacuum. This is obtained by actual test of the pump with closed intake. The zero vacuum—high volumetric end of the curve is assumed (in absence of actual quantity test) to be at 96 per cent volumetric efficiency. The "curve" is almost a straight line, there being a slight sag at the high vacuum end.

Step-by-Step Solution Explained

Of course the strictly accurate way to solve this problem would be to apply integral calculus; however, the step-by-step process set forth here is probably more acceptable. It consists of constructing a table of values for successively increasing vacuum points and assuming that between these steps the volumetric efficiency of the pump has remained constant, at a value corresponding to the average vacuum between steps. We can easily figure the amount of air to be removed from the tank during one of these steps and using average points from the volumetric curve of Fig. 1, the time required for each step of vacuum increase can be figured. The sum of all these time intervals is the total time required.

The first column of Table 1 shows a succession of vacuum values reached. Toward the end of the process, the steps are taken closer together, the upward turn of the right-hand end of the time curve in Fig. 2 being the reason. The second column shows the absolute pressure existing in the tank when each vacuum is reached, expressed in inches of mercury and the values are merely the differences between the barometer (29.6 in.) and the vacuum stated in the first column. In these calculations many complications are avoided if we always measure the air at atmospheric pressure; moreover, Fig. 1 is plotted in this way.

Of course, in such a process of evacuation, the expansion of the air in the tank would reduce its temperature and it might seem as if this should be included in the calculations. It is perfectly possible to figure the temperature for each step assuming no radiation inward, but such calculated temperatures would be considerably different from the facts due to this same radiation.

During the first part of the process, due to the cooling off, the pressure in the tank would be reduced faster because of shrinkage of the air volume. This would slightly shorten the time required to reach the ultimate vacuum desired. However, toward the end of the process, where the time grows longer, radiation inward would warm up the apparatus again, so the vacuum would fall off. To make up for this, the pumping would have to continue longer. By this reasoning, there would

*Engineer in Charge of Rotary Air Compressor Design, Fuller Co., Catasauqua, Pa.

be a slight gain in time during the early stages; but toward the end, while warming up again, the continued pumping must be carried out under the condition of the greatly reduced volumetric efficiency of the higher vacuums. Thus the total time might be considerably extended. Under the circumstances, as no one can estimate how the radiation will act throughout the process, the matter of temperature change had better be neglected. On a large system it would have but a minor effect.

To return to the table, the third column gives the amount of free or atmospheric air remaining in the tank. This is simply the cubic contents of the tank multiplied by the ratio of the absolute pressure then existing in the tank to the absolute pressure of the atmosphere. For instance, for zero vacuum, the pressure inside and outside the tank is the same; namely atmospheric. So the volume of free air in the tank is, obviously, the cubic contents of the tank. Similarly, for the condition of 16 in. vacuum, the absolute pressure within the tank is 29.6 — 16 or 13.6 in. The volume of *free air* within the tank then is

$$100 \times \frac{13.6}{29.6} = 46 \text{ cu ft}$$

In Column 4 are the differences between successive values in the third column, the fourth column then showing the amount of free air removed at each step. The values are tabulated on lines between the values of Column 3 so as to make it clearer that the new values occur in passing from one step to the next.

Fig. 1—Assumed characteristic of vacuum pump used in example in text

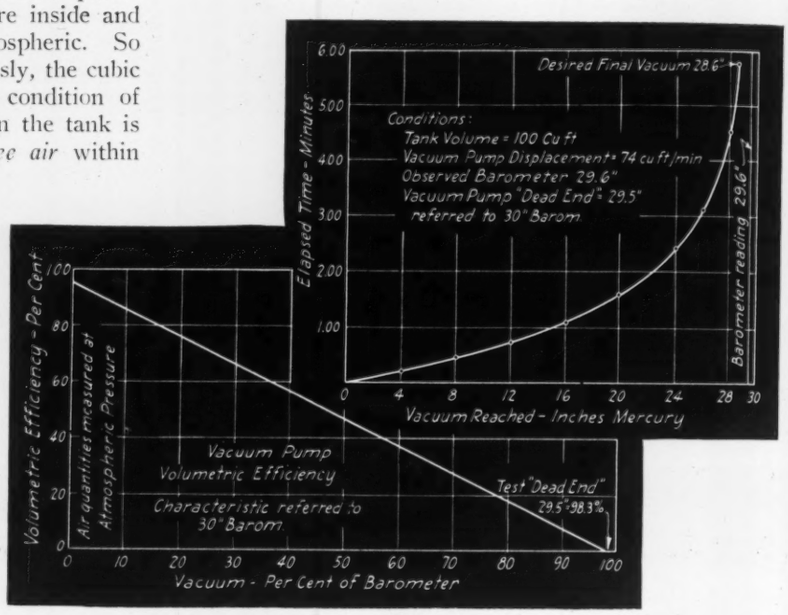
Column 5 shows the average vacuum in per cent of barometer under which the pump was working during each step. For example; during the step from 12 to 16 in. vacuum, the average vacuum was 14. This is 14/29.6 = 47.3 per cent of barometer as shown. From Fig. 1 we see that the volumetric efficiency of the pump for this average condition was 49.8 per cent; also tabulated in Column 6. This volumetric efficiency is expressed as if the air volume were measured at atmospheric pressure. Moreover, the air quantity to be removed during this step, as tabulated in Column 4, is also at atmospheric pressure. The free air the pump will handle per minute for the step between 12 and 16 in. vacuum is then the product of its piston displacement by the average volumetric efficiency, or

$$74 \times 0.498 = 36.8 \qquad \text{(Column 7)}$$

So the time to remove the 13.5 cu ft of free air during this step is 13.5/36.8 = 0.367 minutes as shown in Column 8.

The above process is repeated for each step of increased vacuum and the times required for each step are shown in Column 8. Obviously, the total time to reach any particular vacuum is the sum of the times required for all the steps up to that vacuum, and in Column 9 these "elapsed times" are shown. These are the values which are plotted in Fig. 2 and the total time required is shown by the table to be 5¾ minutes to reach 28.6 in. vacuum on a 29.6 barometer.

Fig. 2—Time curve for example given in text


Desired Final Vacuum 28.6"
Conditions:
Tank Volume = 100 Cu ft
Vacuum Pump Displacement = 74 cu ft/min
Observed Barometer 29.6"
Vacuum Pump "Dead End" = 29.5"
referred to 30" Barom.
Elapsed Time - Minutes
Barometer reading 29.6"
Vacuum Reached - Inches Mercury
Volumetric Efficiency - Per Cent
Air quantities measured at Atmospheric Pressure
Vacuum Pump Volumetric Efficiency
Characteristic referred to 30" Barom.
Test "Dead End" 29.5" = 98.3%
Vacuum - Per Cent of Barometer

Why Overall Average Value Cannot Be Used

It might be supposed by some that this step-by-step process is needlessly long and that the sensible way would be to take an overall average value for the volumetric efficiency and figure from that. To show that this cannot be done, let us take an average value from the curve in Fig. 1. The highest vacuum desired is 28.6 in. on 29.6 barometer, or 96.6 per cent vacuum. Fig. 1 shows the atmospheric volumetric efficiency at this point to be 1.3 per cent. At the start, or at zero

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A practical piping problem quite frequently encountered in certain industrial processes is the calculation of the time required to evacuate a tank, and the selection of the proper size vacuum pump to evacuate a given tank in a given time; an example is the treatment of wood products in creosoting vats.....

Explained here is a step-by-step method of solving such problems which is more easily applied than is the strictly accurate solution involving integral calculus. Fig. 3 is a complete summary of the method, may be kept for handy reference once the method is understood.

Table 1—Summary of Step-by-Step Method of Figuring Time to Evacuate a Tank as Explained in Text

Condition in Tank Inches Mercury		Free Air Cu ft		Average Vacuum Per Cent of Barometer (Barom 29.6)	Vacuum Pump—Each Step			Elapsed Time from start
					Vol Effy Expressed at Atmos Conditions	Free Air Handled cfm	Time reqd to remove minutes	
Vacuum	Abs Press	Remain in Tank	Removed Each Step					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	29.6	100						
			13.5	6.75	89.5%	66.3	.204	.204
4	25.6	86.5						
			13.5	20.3	76.3	56.5	.239	.443
8	21.6	73.0						
			13.5	33.8	63.0	46.6	.289	.732
12	17.6	59.5						
			13.5	47.3	49.8	36.8	.367	1.099
16	13.6	46.0						
			13.5	60.8	36.5	27.0	.500	1.599
20	9.6	32.5						
			13.6	74.3	23.0	17.0	.800	2.399
24	5.6	18.9						
			6.75	84.5	13.0	9.63	.701	3.100
26	3.6	12.15						
			6.75	91.2	6.5	4.81	1.405	4.505
28	1.6	5.4						
			2.02	95.6	2.2	1.63	1.240	5.745
28.6	1.0	3.38						
		Total 96.62					Total 5.745	

Evacuation of a 100 cu ft tank to a final vacuum of 28.6" mercury with 29.6" Barom. Vacuum pump displacement 74 cfm, "Dead End" 29.5" on 30" Barometer.

vacuum, the volumetric efficiency is 96 per cent. The average of these two values is 48.65 per cent, which multiplied by the pump displacement gives 36 cfm of free air handled. The free air in the tank at the start was 100 cu ft, and at the end (28.6 in. vacuum) was, by the table 3.38 cu ft. The difference, 96.62 cu ft, is the total amount to be removed. Therefore, by using one overall average, the time should be

$$\frac{96.62}{36} = 2.69 \text{ minutes, or about one-half the time previously figured.}$$

It is plain that this value is incorrect. As a matter of fact, by Fig. 2, the vacuum reached at this time would be only about 25 in.

Selecting Pump to Evacuate Tank in a Given Time

In the earlier part of this discussion the problem of how to determine what size pump to supply in order to evacuate the tank in a given time was mentioned.

Assume that all conditions of the problem are the same as before, except that we wish to reach 28.6 in. vacuum in 4 minutes and we wish to purchase a pump to do this. The best way is merely to assume an arbitrary pump size and its volumetric efficiency curve, set up a table as described and determine the time for that assumed pump. If the time is too long, the pump size must be increased in inverse proportion to the time. The time for each step will be inversely proportional to the amount of air handled by the pump, or in other words, to the pump displacement, assuming the same volumetric curve. Therefore the total time will be inversely proportional to pump displacement. In our example a 74 cu ft displacement pump required 5¾ minutes, so to do the work in 4 minutes, the pump would require.

$$74 \times \frac{5.75}{4} = 106 \text{ cfm piston displacement.}$$

If the original problem had been to determine the size of pump for a given time rather than the time for a given size pump the calculation would be simplified by assuming a pump having 100 cfm displacement. This would save some slide rule work, and having found the time required by such a pump, the inverse proportion of the times will give the required pump size. Of course commercial pumps must be used, so the next step would be to pick out an actual pump, plot its volumetric efficiency from available data from the manufacturer and recalculate the time by the method described.

Handy Guide for Solving the Problem

As a guide for estimating such problems, Fig. 3 is given. This shows the ideal case of a 100 cu ft tank and 100 cfm displacement for the vacuum pump. On the curve two typical problems and their solutions are given. In this handy location the sample problems and the curve may be filed together and this text need not be referred to, unless one desires again to work out the reasoning. In Problem 1, the time to draw a given vacuum in a given tank is worked out. In Problem 2, the size of pump to draw a given vacuum in a given time is solved. In the sample problems the tank size, the pump size, the time and the vacuum are all odd; but the solutions are shown by the use of the curve in Fig. 3, involving a 100 cu ft tank and a 100 cfm displacement vacuum pump. For most ordinary purposes this curve will be found very helpful for a preliminary figure. An ordinary commercial vacuum pump has been

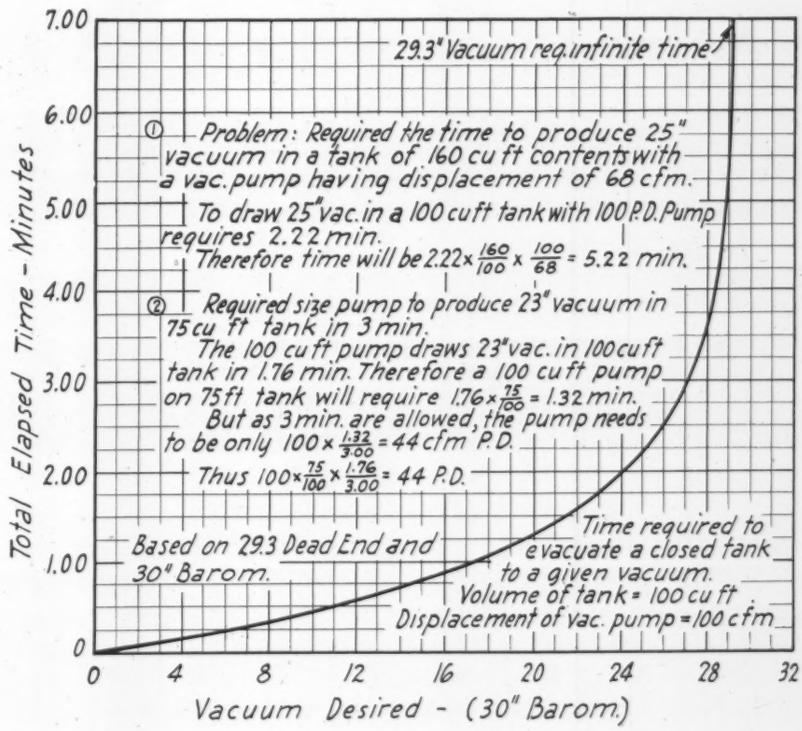
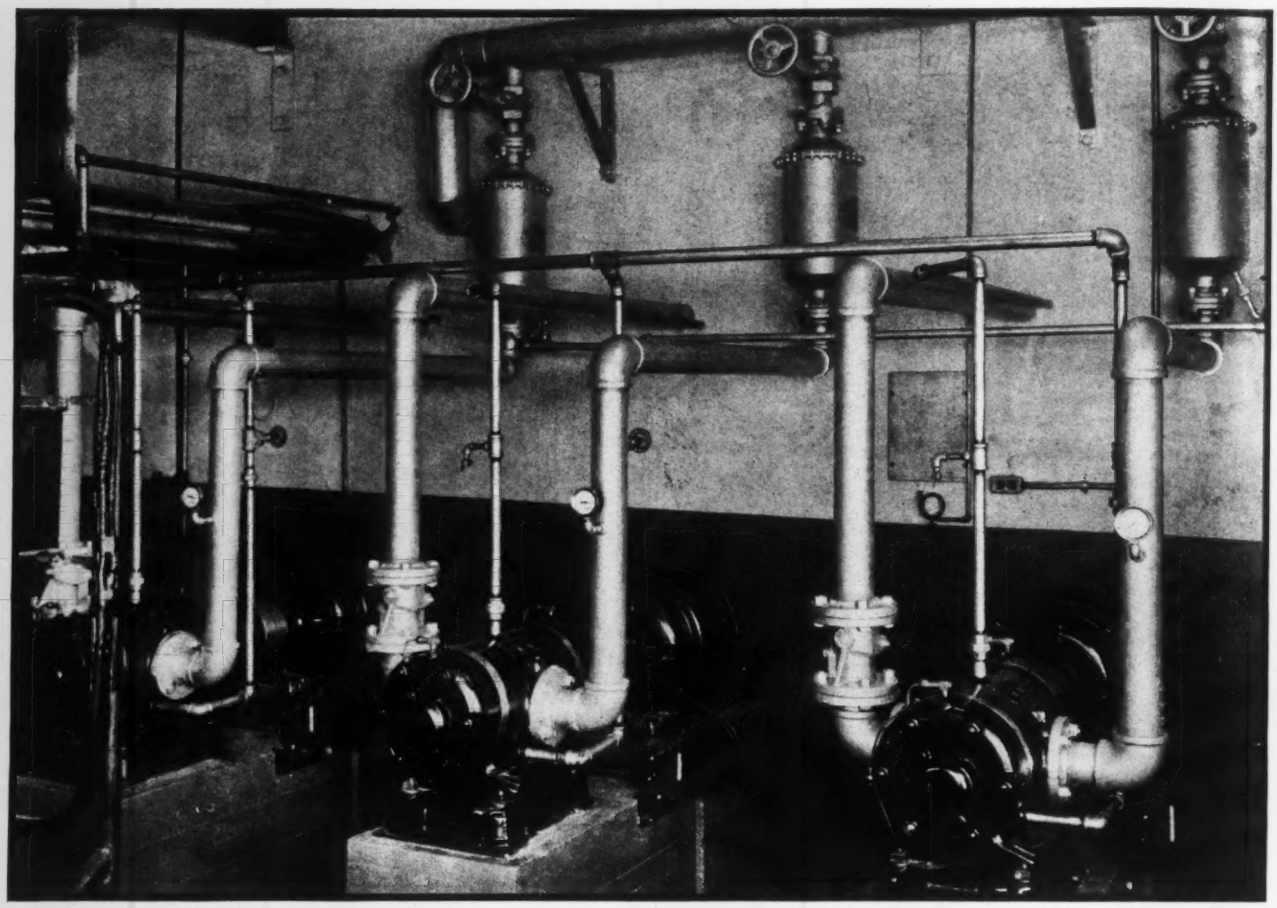

29.3" Vacuum req. infinite time
① Problem: Required the time to produce 25" vacuum in a tank of 160 cu ft contents with a vac. pump having displacement of 68 cfm.
To draw 25" vac. in a 100 cu ft tank with 100 P.D. Pump requires 2.22 min.
Therefore time will be 2.22 × 160/100 × 100/68 = 5.22 min.
② Required size pump to produce 23" vacuum in 75 cu ft tank in 3 min.
The 100 cu ft pump draws 23" vac. in 100 cu ft tank in 1.76 min. Therefore a 100 cu ft pump on 75 ft tank will require 1.76 × 75/100 = 1.32 min.
But as 3 min. are allowed, the pump needs to be only 100 × 1.32/3.00 = 44 cfm P.D.
Thus 100 × 75/100 × 1.76/3.00 = 44 P.D.
Based on 29.3 Dead End and 30" Barom.
Time required to evacuate a closed tank to a given vacuum.
Volume of tank = 100 cu ft
Displacement of vac. pump = 100 cfm
Total Elapsed Time - Minutes
Vacuum Desired - (30" Barom.)
0
1.00
2.00
3.00
4.00
5.00
6.00
7.00
0
4
8
12
16
20
24
28
32

Fig. 3—Handy guide for estimating time required to evacuate a tank and selecting the vacuum pump. Problem 1 shows the method for determining the time required to draw a given vacuum in a given tank, and Problem 2 indicates how to select the size of pump to draw a given vacuum in a given time



Three rotary vacuum pumps used in forming bottles at a glass works

assumed. However, for higher desired vacuums and for pumps able to pull higher vacuums, this curve will not apply and either integration or the step-by-step process here described must be used.

Fig. 3 is for 30 in. barometer. If the barometer is not 30 in., express the desired vacuum as a per cent of the actual barometer and interpret this again as inches on a 30 in. barometer. Example: Desired vacuum 27.4 in. on 29.5 in. barometer. This is $27.4/29.5 = 92.9$ per cent vacuum which is $0.929 \times 30 = 27.9$ on a 30 in. barometer. Use 27.9 in. as the desired vacuum in entering Fig. 3. Again it is cautioned that, especially at the higher vacuums, the total time will be greatly changed if the "dead end" of the pump differs from that assumed in Fig. 3, or 29.3 in. on a 30 in. barometer. That is why the calculation method has been set forth in detail.

As a slight fall-off in pump efficiency will considerably modify the result, it is always best to supply plenty of pump capacity rather than to skimp. Especially is this advisable because the only result of too large a pump would be to reach the desired vacuum a little sooner and, contrary to the usual process of compression from atmosphere, the power required falls off rapidly as the vacuum increases beyond the peak, at about 15 in. vacuum. The higher the vacuum, the less the power.

"What Air Conditioning Did"—

[*Concluded from page* 140]

of getting soft and turning in color during hot weather. Moreover, in an atmosphere where the humidity is excessive, as is often the case in a warehouse, hard candies get sticky and become unsaleable.

Mr. Stallman says: "We find that these worries have been removed by the constant temperature and relative humidity maintained in our warehouse. In addition, it has been possible for us to stock many higher quality candies, which retailers are capable of selling in the summer, but which the average jobber cannot stock because of spoilage. This has meant additional volume for us during the lean candy months. Not only has the air conditioning kept our stock in good condition, but it has enabled us to buy more freely, without fear of loss through spoilage, thereby increasing our service to the retail trade."

(5) Dollar volume of business more than doubled in the S. & S. Coffee Shoppe, Augusta, Ga., as the result of installing air conditioning equipment, according to Roy Scarborough, the owner. "The cost of installing and operating the equipment has been more than justified by the increase in business which occurred contemporaneously with the adding of air conditioning," he says. "The dollar volume of my restaurant business more than doubled during the last summer, and I am confident that air conditioning has both attracted new business and also, by assuring the comfort of patrons, caused more food to be consumed than would have been desired in a less comfortable atmosphere."

(Acknowledgment for Items 1-4 is made to York Ice Machinery Corp., and for Item 5 to Kelvinator Corp.)

Handling Fuel Oil

Part 4: Pressure Regulation and Straining

By **Kalman Steiner***

THUS far we have reviewed[1] the types of pumps used for transporting fuel oil and have examined the laws governing liquid flow and the power consumed in creating that flow. The three elements—pump, piping and power—plus a fourth—metering—might be termed *quantitative;* they determine the quantity of oil moved. The remaining elements which complete the make-up of a fuel oil handling system are *qualitative;* they determine how, or in what physical condition, oil is delivered to the burner nozzles. These units are the preheater, pressure regulator, and strainer. The subject of preheaters and preheating is too broad to be treated in this paper; suffice it to say that preheating must be provided with the heavier fuels, and that the amount of preheating is controlled so as to deliver oil to the nozzles at the most favorable temperatures.[2] Pressure regulators and strainers are discussed here, and metering, or feed regulation, although a quantitative operation, will be considered in the next and last article, since it is the final operation of a pumping system, and occurs at the point where oil enters the burners.

Methods of Regulating Pressure

The almost universal method of regulating oil pressure on oil burning systems is to discharge the pump against some type of relief valve placed near the pump outlet. These relief valves vary considerably in their construction, but all of them contain a balancing device to create a pressure against the pump discharge, and this device is usually adjustable to give some range of pressure variation.

In the simplest type (used frequently where operating pressures are between 5 and 25 lb per sq in., and occasionally for higher pressures) a valve stem and plunger are forced against a valve seat by an adjustable spring. The spring tension determines the pressure which the pump must develop to push oil past the plunger. Hence, oil taken to the nozzle from any point between the pump outlet and the relief valve will be delivered at the pressure so determined. This type of pressure regulator has the virtue of simplicity, although there are several objectionable features.

Both the valve seat and the plunger are subject to eroding and corroding action, and wire-drawing also exerts its effect upon these parts. As a result, the plunger becomes scored and the seat grooved after a period of use, so that pressure regulation first becomes irregular and then may become impossible. To remedy this condition the plunger and seat must be re-surfaced by grinding with abrasive, much the same as with the valves of an automobile. Another objection is the tendency of the spring gradually to lose its elasticity, ultimately requiring its replacement. Most serious is the fact that this type of valve is easily clogged or rendered inoperative by the entrance into it of small solid particles or stringy materials such as tars and greases. For handling heavy fuel oil, therefore, this is not an ideal means of pressure regulation.

Domestic type pressure atomizing burners invariably employ some form of a compound pressure relief valve in conjunction with a pressure cutout, the function of the latter being to stop the flow of oil to the nozzle at the moment that the pressure drops below some predetermined minimum, usually about 60 per cent of the operating pressure. These two parts—the pressure regulator and the cutout—may be housed separately as two units, but current practice is usually to place them together as a single piece of apparatus with adjustments for the two functions it must serve. Commercial valves of this kind take the form of one of three types—the piston, bellows, or diaphragm type, according to construction. The common operating pressure for such regulating valves is from 75 to 150 lb per sq in., although special types are made for pressures as high as 400 lb. These regulators are subject to the same objections as the pressure relief valve first described, but in the domestic valves seat erosion and loss of spring tension are more marked, because of the higher operating pressures, while clogging is of little concern since domestic fuels are lighter and cleaner and hence not likely to carry sediment.

Certain manufacturers of fuel oil equipment employ unusual means of controlling oil pressure, such as variation of eccentricity of pump gears, or variation of gear mesh by lateral sliding of the gears, but to date none of these has come into extensive use. No doubt new mechanisms for pressure regulation will be developed.

Types of Strainers

Fuel oil strainers can be classified as perforated metal, wire mesh, metal disc, and filter cloth. Roughly, their applications vary in the order named from the heaviest oils to the lightest.

Perforated metal cylinders, closed at one end and open at the other, are commonly used in bulk operations where the chief purpose of the strainers is simply to protect pumping equipment by keeping out of the pumps relatively large foreign bodies—pebbles, sticks, etc. The cylinders are contained within castings which are so formed that the flow of oil through the assembly is directed into the open top of the cylinder and out through the walls and bottom, with provision made against short-circuiting—that is, oil passing from inlet of strainer body to outlet without having to pass through the cylinder. Thus the solid matter which the strainer removes from the liquid is caught and retained within the inside of the cylinder, so that by lifting the cylinder out of the strainer body all the solid matter is removed with it. The cylinder may then be cleaned and replaced, and the strainer body capped up for another period of use.

*Chief Engineer, Consumers Petroleum Co., Chicago, Ill. Copyright, 1936, by Kalman Steiner.

[1] See HEATING, PIPING AND AIR CONDITIONING, November, 1935, p. 538; December, 1935, pp. 575-576; February, 1936, pp. 91-92.

[2] See "Preheating of Fuel Oil," by Kalman Steiner and Paul R. Unger, HEATING, PIPING AND AIR CONDITIONING, April, 1931, p. 297, for a discussion of this part of the subject of handling fuel oil.

Perforated metal cylinders are sometimes applied to smaller units also, such as moderate sized industrial oil burners using the heavier grades of fuel oil. The perforations are then smaller in diameter and more numerous, in order that the smaller sized particles of sediment will be retained without there being too much resistance to flow through the strainer. Usually a strainer of this type will be followed by another strainer of wire mesh to perform the final cleaning operation just before the fuel enters the nozzle or atomizer.

Wire mesh strainers are made in a variety of shapes and sizes, and constitute the most important group. The mesh itself is a metallic cloth woven from wire, and a wide range of variation is possible in the diameter of the wire and the spacing between them. Some meshes are woven of such fine wire placed so closely together that only the very lightest fuels, such as kerosene or distillate, will pass through them. Commercial wire mesh strainers range from 30 wires per lineal inch to 100 wires, and are designated by the number of wires per inch, as 30 mesh or 100 mesh, etc. To be completely descriptive, however, the terminology should also state the wire diameter.

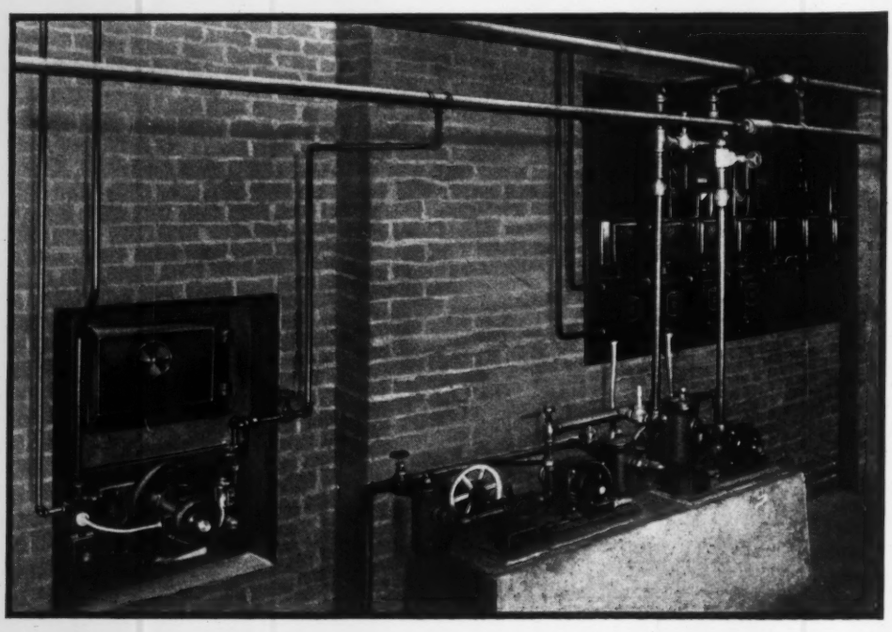
As in the case of the perforated metal cylinder, the baskets for these strainers should be permitted to catch sediment on the inside, to facilitate removal from the strainer body. Some strainer bodies are constructed so that oil passes from the outside to the inside of the basket, so that sediment is retained on the outer surface of the basket. Subsequently, as the basket is being removed from the body, portions of the accumulated sediment are washed back into the strainer body and must be drained out by removing a plug at the bottom of the body. In other forms, the body cap is at the bottom, so that when opened the basket and all other contents of the body are dropped out. The objection to this is the difficulty of replacing the basket and strainer cap after each cleaning operation.

The third group of strainers is built up of a series of metallic discs, stacked in a column with close clearances between consecutive discs. The discs are arranged to communicate into a common tube at their centers. Oil enters into the clearances between the discs at their circumferences; particles of solid matter of greater dimensions than the clearance are stopped at the outer surface of the column of discs, and from there are removed by scraping the surface of the column. This cleaning operation is accomplished by turning the crank of a shaft which extends through the strainer body to a convenient point on the top. The shaft communicates to a scraping edge which is rotated over the column surface by turning the crank outside. The sediment thus scraped clear falls to the bottom of the strainer body and can be released at intervals by removing the bottom plug.

The filter cloth strainer is an adaptation of the type used on automobiles for filtering lubricating oil. In order that as much filtering surface as possible may be contained within a strainer body, the cloth is arranged in layers folded into an accordion-like form over a wire skeleton. Obviously, it is imperative that the flow of oil be from the outside toward the inside, for if the reverse occurred, cleaning of the filter surface would be impossible. In practice, filter cloth strainers are restricted to the lighter or domestic fuels, as they foul up too rapidly when used on heavier industrial oils.

In general, strainers, regardless of type, must be designed for minimum loss of head as the fluid passes through. The initial pressure drop through the strainer becomes progressively greater as the accumulation of sediment on the cleaning surface impedes flow. The frequency of cleaning is therefore determined by the total amount of original surface, the percentage of sediment in the oil, and the permissible pressure drop through the strainer. Wire mesh strainers are frequently used on suction lines, where of course the force creating flow is the atmospheric pressure on the storage tank. A vacuum gauge will therefore show the amount of vacuum needed to maintain flow through the strainer; when the vacuum gauge reading has mounted to a point approaching or exceeding 28 in., flow will cease. In practice, strainers should be cleaned before this limiting pressure drop has been reached. When the strainer is located in a pressure line, then pressure gauges on the inlet and outlet sides will show the pressure drop through it, so that cleaning may be timed from a knowledge of the pressures available in the pumping system.

[The next of Mr. Steiner's articles will cover metering, or feed regulation.—The Editor.]



Oil pumps, strainers, and pressure regulators on a theater installation supplying oil to a battery of five warm air furnaces

New Uses for the Psychrometric Chart in Simplifying Air Conditioning Problems

By **William Goodman***

Part 2—The author continues his explanation of the solution of air conditioning problems by means of a "psych" chart with several typical examples showing the use of the method in determining the required state of the air supply to meet given room conditions, and the conditions which can be maintained with a given air supply

IN Part 1 of this article, published last month, a method of solving air conditioning problems with the psychrometric chart was outlined. The use of "heat ratio lines" was explained, and a table of the value of the "heat ratio angle" for various sensible heat ratios[1] was presented. The several examples which follow clarify the use of these heat ratio lines.

Required Wet Bulb of Air Supply

EXAMPLE 1—A conditioned room is to be maintained at 78 F dry bulb and 50 per cent relative humidity. Eighty per cent of the total heat gain is sensible heat. If the air supply entering the conditioned room is to have a dry bulb temperature of 58 F, find the required wet bulb temperature of the air supply.

Solution—From Table 1 (reproduced here), the heat ratio angle is 17°-21′. Spot the point *A* on Fig. 4 at the intersection of the 78 F dry bulb line and the 50 per cent relative humidity curve. Through the point *A*, draw the heat ratio line *A-C* at an angle of 17°-21′ with the horizontal. The point *B* is located at the intersection of the line *A-C* with the vertical line of 58 F dry bulb temperature. The required wet bulb temperature of the air supply as read at the point *B* is therefore 56.4 F.

Check—

Sensible heat absorbed by each pound of air = 0.24 (78-58)

= 4.8 Btu

Total heat content of air at room wet bulb temperature of 65.3 F = 29.87 Btu per lb

Total heat content of air at wet bulb temperature of 56.4 F = 23.88

Total heat absorbed = 5.99 Btu per lb

$$\text{Sensible Heat Ratio} = \frac{4.8}{5.99} = 0.80$$

EXAMPLE 2—A room has a sensible heat gain of 10,000 Btu per hr and a latent heat gain of 2200 Btu per hr in the morning. In the afternoon, due to changing conditions in the room, the sensible heat gain is 8800 Btu per hr, while the latent heat gain is 3400 Btu per hr. The room is to be maintained at 70 F dry bulb and 50 per cent relative humidity at all times. The air leaving the conditioning equipment always has a relative humidity of 90 per cent. Find the required dry and wet bulb temperatures of the air supply for both conditions.

Solution—

$$\text{Heat ratio in morning} = \frac{10{,}000}{10{,}000 + 2200}$$

$$= \frac{10{,}000}{12{,}200} = 0.82$$

Heat ratio angle (from Table 1) = 15° - 21′

$$\text{Heat ratio in afternoon} = \frac{8800}{8800 + 3400}$$

$$= \frac{8800}{12{,}200} = 0.72$$

Heat ratio angle (from Table 1) = 25° - 56′

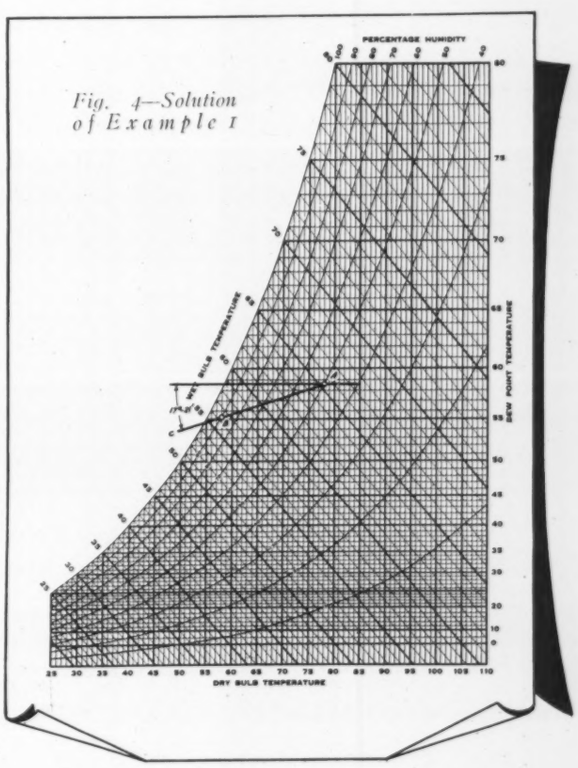


Fig. 4—Solution of Example 1

*The Trane Co., LaCrosse, Wis. Copyright, 1936, by William Goodman.

[1]The sensible heat ratio is the proportion of the total heat gain of a room which is sensible heat, the balance being latent heat.

In Part 1 of this article, Column 1, p. 89, February issue, latent heat of water vapor was stated to be about 1150 Btu per lb. This should of course be 1050 Btu per lb.

The two heat ratio lines for the above conditions are shown on Fig. 5. Both lines pass through the point *A*, which represents the room condition of 70 F dry bulb and 50 per cent relative humidity.

Reading from Fig. 5, at the point *B* where the heat ratio line cuts the curve of 90 per cent relative humidity, the air supply must have a dry bulb temperature of 50 F and a wet bulb temperature of 48.5 F for the morning condition. For the afternoon condition, the air supply must have a dry bulb temperature of 44.5 F and a wet bulb temperature of 43 F.

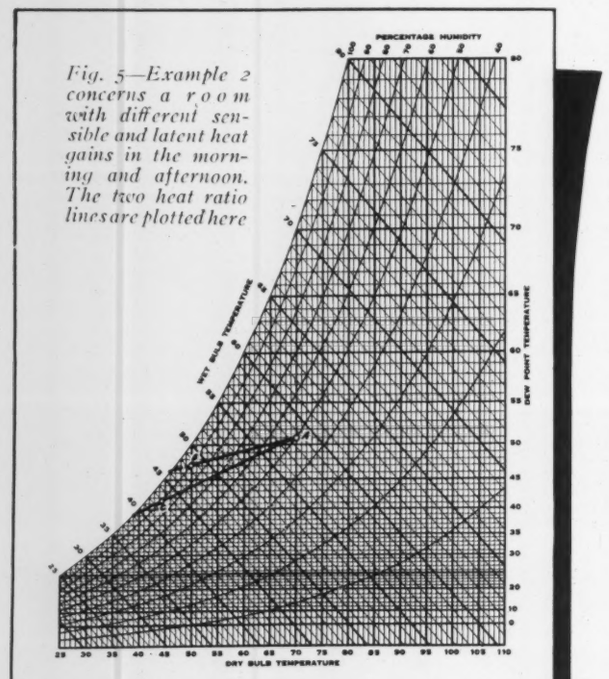


Fig. 5—Example 2 concerns a room with different sensible and latent heat gains in the morning and afternoon. The two heat ratio lines are plotted here

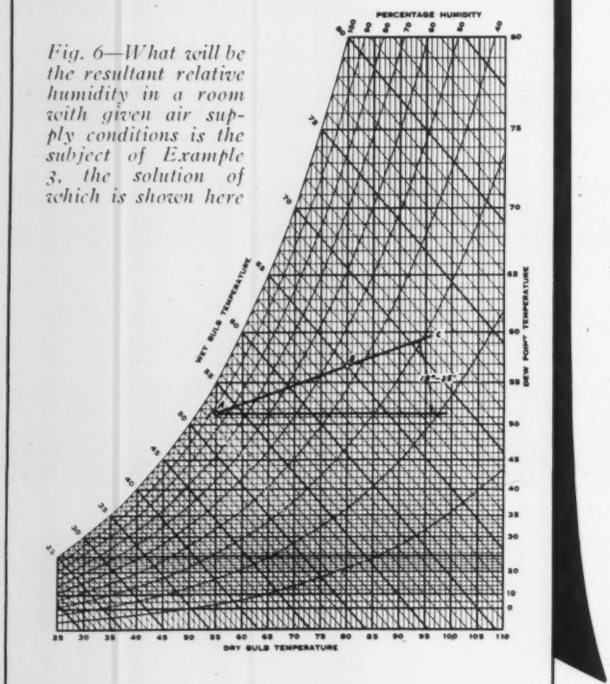


Fig. 6—What will be the resultant relative humidity in a room with given air supply conditions is the subject of Example 3, the solution of which is shown here

Room Conditions with Given State of Air Supply

The heat ratio line can be used not only to find the required state of an air supply for a given room condition, but also to solve the reverse problem of finding the resultant room condition if the state of the air supply is given.

EXAMPLE 3—Air leaving a bank of cooling coils has a dry bulb temperature of 55 F and a wet bulb temperature of 53 F. This air is delivered to a room having a sensible heat ratio of 0.78. If the dry bulb temperature is maintained at 80 F by a thermostat, what will be the resultant relative humidity in the room?

Solution—For a heat ratio of 0.78 the heat ratio angle is 19°-25′.

The point *A*, Fig. 6, represents the given condition of the air leaving the cooling coils. From the point *A* lay off the heat ratio line *A-C* at an angle of 19°-25′ with the dew point line through *A*. The line *A-C* intersects the vertical line of 80 F dry bulb at point *B*; point *B* therefore represents the condition of the room air. The relative humidity of the room will be 43 per cent, as read from point *B*.

In central air conditioning systems many rooms are sometimes supplied with air from one conditioning unit. Since the dry and wet bulb temperature of the air supply to all rooms is the same, it is apparent that those rooms having the highest sensible heat ratio will have the lowest relative humidity.

Inspection of Figs. 4, 5 and 6 shows that the lowest temperature which an air supply may have is the temperature at the point where the heat ratio lines intersect the curve of 100 per cent relative humidity. This fact has little significance as there is no air conditioning equipment commercially available which can provide a

Table 1—Value of Heat Ratio Angle for Various Sensible Heat Ratios

Sensible Heat Ratio	Heat Ratio Angle	Sensible Heat Ratio	Heat Ratio Angle
0.00	90°-0′	0.50	51°-20′
0.02	89°-4′	0.52	49°-5′
0.04	88°-5′	0.54	46°-48′
0.06	87°-5′	0.56	44°-29′
0.08	86°-1′	0.58	42°-9′
0.10	84°-55′	0.60	39°-48′
0.12	83°-46′	0.62	37°-27′
0.14	82°-35′	0.64	35°-7′
0.16	81°-20′	0.66	32°-47′
0.18	80°-2′	0.68	30°-28′
0.20	78°-42′	0.70	28°-11′
0.22	77°-17′	0.72	25°-56′
0.24	75°-49′	0.74	23°-42′
0.26	74°-18′	0.76	21°-33′
0.28	72°-43′	0.78	19°-25′
0.30	71°-4′	0.80	17°-21′
0.32	69°-22′	0.82	15°-21′
0.34	67°-36′	0.84	13°-24′
0.36	65°-46′	0.86	11°-30′
0.38	63°-53′	0.88	9°-41′
0.40	61°-56′	0.90	7°-54′
0.42	59°-55′	0.92	6°-12′
0.44	57°-51′	0.94	4°-34′
0.46	55°-41′	0.96	2°-59′
0.48	53°-33′	0.98	1°-28′
		1.00	0°-0′

saturated air supply. However, the temperature at which the heat ratio line intersects the curve of 100 per cent relative humidity is interesting because it gives the lowest temperature at which air can be supplied to an enclosure and still maintain the specified conditions.

Further, inspection of the heat ratio lines of Figs. 4, 5 and 6 shows that, theoretically, there is an infinite number of combinations of dry and wet bulb temperatures which may be selected for an air supply. Practically, however, the combination of dry and wet bulb temperatures selected for an air supply must be one which can be obtained with the equipment used to condition the air. It must be remembered that the air leaving the cooling equipment will ordinarily be delivered to the conditioned room without further treatment. Therefore, the conditioning equipment selected must be able to reduce the dry and wet bulb temperatures of the air supply to a point which will fall on the heat ratio line for the room in question. Commercial air cooling equipment tends to provide air which is very close to being saturated. The air leaving cooling equipment such as is ordinarily used for comfort cooling installations will have a relative humidity, roughly, of 90 per cent. Therefore, the point selected on the heat ratio line must always lie close to the curve of 90 or 100 per cent relative humidity. However, each designer, knowing the exact characteristics of the cooling equipment he is planning to use, can select the exact combination of dry and wet bulb temperature on the heat ratio line which his equipment can provide.

EXAMPLE 4—A conditioned room is to be maintained at 75 F dry bulb and 64 F wet bulb. The sensible heat gain of the room is 40,000 Btu per hr, while the latent heat gain is 14,000 Btu per hr. If the characteristics of the cooling equipment are such that the air leaving it will have a relative humidity of 90 per cent, find the required dry and wet bulb temperatures of the air supply.

Solution—

$$\text{Total heat gain} = 40{,}000 + 14{,}000 = 54{,}000 \text{ Btu per hr}$$

$$\text{Heat ratio} = \frac{40{,}000}{54{,}000} = 0.74$$

From Table 1, the heat ratio angle is 23°-42′. Spot the point *A* on Fig. 7 at the intersection of the 75 F dry bulb line and the 64 F wet bulb line. Through the point *A* draw the heat ratio line *A-C* at an angle of 23°-42′ with the horizontal. The point *B* is located at the intersection of the line *A-C* with the curve of 90 per cent relative humidity. The required condition of the air supply as read at the point *B* is therefore 56 F dry bulb and 54.5 F wet bulb.

Quantity of Air Circulated

Since the conditioning equipment can provide only one combination of dry and wet bulb temperature which will intersect on any one heat ratio line, it is apparent that the air quantities to be circulated to the conditioned room cannot be selected first. To do so would be equivalent to fixing the dry bulb temperature of the air supply. Examination of Equation 1 (see February article) will show why this is true. Since both the sensible heat gains and the desired room dry bulb temperature are known, insertion of the air quantity in Equation 1 results in a solution for the dry bulb temperature of the air supply. With the dry bulb temperature of the air supply determined by Equation 1, it is apparent, from Equation 4, that the wet bulb temperature of the air supply has been fixed. Thus, by arbitrarily selecting the air quantities to be circulated, both the required dry

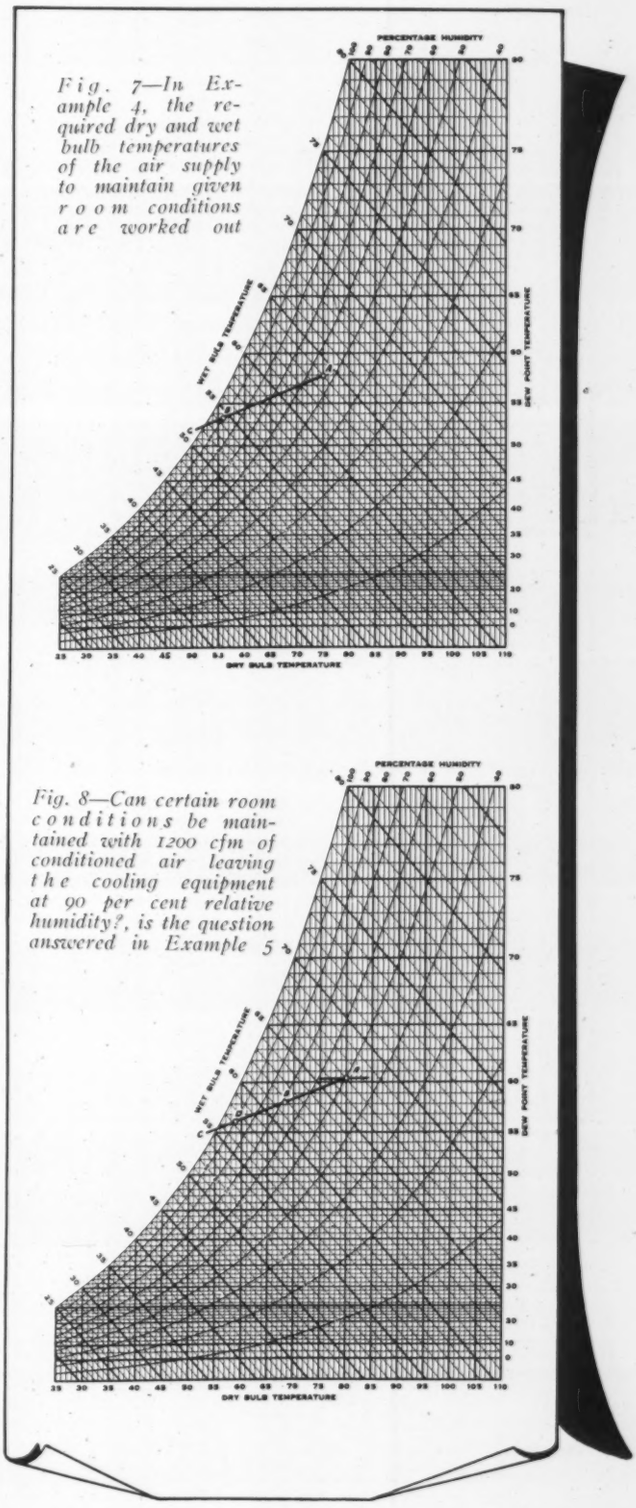


Fig. 7—In Example 4, the required dry and wet bulb temperatures of the air supply to maintain given room conditions are worked out

Fig. 8—Can certain room conditions be maintained with 1200 cfm of conditioned air leaving the cooling equipment at 90 per cent relative humidity?, is the question answered in Example 5

and wet bulb temperatures of the air supply are fixed without any reference as to whether or not such a combination of dry and wet bulb temperatures can be obtained from the conditioning equipment.

The following example illustrates this point.

EXAMPLE 5—A conditioned room which has a sensible heat gain of 15,200 Btu per hr and a latent heat gain of 4800 Btu per hr is to be maintained at a dry bulb temperature of 80 F and a relative humidity of 50 per cent. The characteristics of the air cooling equipment are such that the air leaving it has a relative humidity of 90 per cent. The owner has requested that 1200 cfm of outside air be conditioned and delivered. Can the designer comply with his request?

Solution—

$$\frac{60}{13.3} \times 1200 \text{ cfm} = 5420 \text{ lb of air per hr}$$

Substituting in Equation 1:

$15{,}200 = 0.24 \times 5420\ (80\text{-}t_s)$

$t_s = 68.3$ F, required dry bulb temperature of the air supply.

$$\text{Heat Ratio} = \frac{15{,}200}{20{,}000} = 0.76$$

The heat ratio angle corresponding to 0.76 is 21° 33′. Spot the point *A* on Fig. 8 representing the room condition of 80 F dry bulb and 50 per cent relative humidity. Draw the line *A-C* at an angle of 21°-33′ through point *A*. Spot point *B* at the intersection of the line *A-C* with the dry bulb line of 68.3 F which is the required dry bulb temperature of the air supply. Reading the state of the supply air at point *B*, we find that the wet bulb temperature of the air supply would have to be 61.9 F while its relative humidity would be slightly less than 70 per cent.

Since the characteristics of the cooling equipment are such that air can be obtained at about 90 per cent relative humidity, that is at point *D*, it is obvious that the conditions of this problem cannot be satisfied if 1200 cfm must be provided.

[Part 3, to appear next month, will include additional examples, and will discuss cases where the sensible heat ratio is so low that reheating is required.—THE EDITOR.]

Velox Boiler for Heating

AN article by E. S. Dean in the Aug. 23, 1935, issue of *The Engineer* tells briefly of two plants and in more detail of a third, where the Velox hot water boiler has been installed for heating purposes. The illustration showing the layout of the plant is of a character that cannot be reproduced. On the right is the combustion chamber with the burner and retractable ignition coil at the top and the tubular heating elements arranged as a water wall around the combustion chamber shell. On the extreme left is the preheater and economizer, and in the center is the supercharging unit. On the left of this unit is the gas turbine driving the axial flow compressor, and this is coupled through gearing to a variable speed commutator motor, which is used for starting and regulation. The boilers are put into service, shut down, and regulated by push-button control from the switchboard, and interlocks insure that the operations are carried out in the right sequence. In this particular installation the gas turbine at full load generates about 50 kw more power than is required by the air compressor, and this surplus power is fed back into the system through the motor.

The heat release in this type of boiler reaches a value of 700,000 to 900,000 Btu per cu ft per hr, and the average rate of heat absorption under normal operating conditions amounts to 110,000 Btu per sq ft per hr. As far as fuel economy is concerned, a thermal efficiency of 87 to 89 per cent, based on the gross calorific value of the oil, is obtained at full load, and there is little variation in efficiency over a wide range down to below 25 per cent of maximum capacity.

In the installation at the City University in Rome two oil fired Velox boilers are used. In view of the comparatively small size of the units it has been possible to build the supercharging unit directly onto the boiler itself. The air compressor consists of a central standard radial flow impeller. The gas turbine is of the single stage impulse type and is connected through gearing to an auxiliary motor. (Reprinted by permission from *Mechanical Engineering*. For a description of the Velox steam generator, see *Mechanical Engineering*, August, 1935, pp. 469-478.)

Solving Air Conditioning Problems

THE EDITOR—I was very much interested in the article on solving air conditioning problems with the psychrometric chart in the February issue. It occurred to me that this method might be further simplified in use by close approximations, which would make unnecessary the use of Table 1, p. 90. (Table republished in this issue, p. 148.—ED.)

If the digits under "Sensible Heat Ratio" are added to the degrees of angle under "Heat Ratio Angle", the result in most cases approximates a total of 100. For instance, Sensible Heat Ratio, 0.58 plus angle, 42 degrees, equals 100. Given a Sensible Heat Ratio of 0.56 and subtracting from 100 gives 44 degrees; actual angle 44° 29′, which is closer than the ordinary measurement with a protractor.

This relationship becomes less accurate with Sensible Heat Ratios under 0.20. This means the relationship would hold in most cases, except where the case was primarily a drying operation.—RALPH F. COHN.*

Converting Centigrade to Fahrenheit

An easy way to convert degrees Centigrade to degrees Fahrenheit is: "Double, subtract one-tenth, add 32."

Example—Given 86 C. How many degrees F? $2 \times 86 = 172$. $172 \div 10 = 17.2$. $172 - 17.2 + 32 = 186.8$ F.

This rule may be remembered or applied with greater convenience than the ($F = 9/5\,C + 32$) formula.

*Chief Engineer, Reynolds Wire Co., Dixon, Ill.

ESTIMATING PIPING

—*Preparation of Sketches*

By **E. W. Norris***

Preparation of flow diagrams and sketches to be used as the basis for estimating piping is discussed here. The methods described are the result of considerable experience and, says the author, if adhered to will be found to save time as well as money

IN a previous article on estimating for piping[1] the work of preparing an estimate was discussed and suggestions were made for arranging the work and for securing the necessary information. Reference was made to the use of sketches as bases for estimates. The present article is devoted to the preparation of these sketches so as to render them most effective both for estimating and for the preparation of the formal plans and specifications.

Flow Diagram an Effective Tool

The flow diagram is a well known device for the illustration of processes and the general arrangement of piping. Usually it is a rather rudimentary affair and because careful thought is not expended on piping problems till the actual plans are in production, the possibilities of the flow diagram are not generally appreciated. As a matter of fact the bulk of design work should be expended on the diagram, for in this stage changes can be made readily and alternative designs can be rapidly estimated and decisions made without loss of time and money for changing actual plans or, worse yet, for altering partially completed work. Properly drawn diagrams accompanied by estimates prepared from them form the fastest and one of the most effective means of presenting data on piping for the consideration and judgment of executives.

A flow diagram, like the estimate and drawings for which it is the basis, is prepared as a step in the installation of a piping system—simple or elaborate. To begin, therefore, the purpose and characteristics of the system must be known and described clearly. The description should be as complete as possible, though as a rule it will be found, as work progresses, that more data must be supplied to cover points not originally considered.

With the problem defined, the diagram is started by laying out the principal pieces of equipment and the connecting pipe lines. It is helpful to follow some rough scheme of layout similar to the actual arrangement but changing proportions and relative positions so as to emphasize the pipe lines and avoid crossing and re-crossing connections. With the main items laid out, the secondary equipment and the interconnecting lines may be drawn in. These could be put in at the same time as the primary layout but a much clearer arrangement will be obtained if the work is first concentrated on the most important class of service. For instance, in laying out the steam piping in a power house it is preferable to lay out the general scheme for the main steam lines. After these have been worked out in a satisfactory way, the auxiliary steam lines may be put in. Thus, the consideration of the main system is not disturbed by less important lines.

Location of Valves—When the scheme of connections has been arranged to give the necessary flow from point to point, the valve locations should be chosen and the valves indicated. In this work it is essential to keep in mind the requirements of the system for continuity of service and the possibilities of taking down parts of the system for repair or cleaning. If the plant can be shut down periodically so that any valve can be repaired or removed the valving can be made very simple, but if it is essential to keep the major part of the plant in operation continuously, then great care must be taken to be sure that the system is divided into sections of such size and arrangement that every valve and pipe line can be worked on without shutting down more than a predetermined part of the plant capacity. In some classes of process piping the system must be flushed out periodically and in these pipe lines provision must be made to do this cleaning completely so that there are no pockets where material can remain and harden or otherwise deteriorate. Provision also must be made for supplying the water, steam, or air used in flushing at the proper pressure and temperature. It should not be overlooked that the material flushed from the system must be carried away, and drain lines are required for this purpose which must deliver the wastage into suitable tanks or other process equipment. These items should all be noted on the flow diagram as memoranda for estimating and design purposes.

Size of the Lines—The next matter for consideration is the size of the lines. For this purpose the quantities of material flowing in each part of the system must be stated and set down on the diagram. In most work these quantities are simple matters but not infrequently the rate of flow varies so much that some little study must be given to determine what conditions present the maximum requirement for any particular line. With the capacity data, the pressures and the amount of pressure loss that can be tolerated in the various parts of the system should be determined.

A good example of this is the steam and feed water piping for a modern steam power installation. Reduced to simple form these may be tabulated thus:

*Piping Engineer, Boston, Mass.

[1] HEATING, PIPING AND AIR CONDITIONING, January, 1936, pp. 19-21.

Steam Piping		Water Piping	
Pressure at throttle	400 lb	Drum pressure	435 lb
Press. loss in turbine lead	5 lb	Press. loss in regulating valves	40 lb
Header pressure	405 lb	Press. loss in feed piping	10 lb
Press. loss in boiler lead	10 lb	Static head	15 lb
Press. loss in superheater	20 lb	Pump discharge pressure	500 lb
Drum pressure	435 lb		

Some of the more intricate parts of this tabulation have been omitted but it shows in general the build up of pressure through a system and the effect that different systems may have on one another when closely related. It is a very common fault to omit some of the steps in a calculation of this kind and the results of such omissions are difficult to correct afterward. By tabulating the pressures and losses such omissions are minimized.

When the diagram has been completed in its essentials it is necessary to carry the work a step nearer an actual scale drawing by considering the physical layout of the plant and estimating the probable location of the various lines. In this study it may be necessary to rearrange the diagram for convenience in fitting it to the actual arrangement. It should not be necessary nor is it desirable to approach a scale drawing but the sequence of equipment and the relative locations should be correct. This enables the actual dimensions of the parts to be estimated and accessibility to be studied. The general operation of the system in actual service should be thought out and all normal and emergency conditions allowed for. Such problems as grouping of controls and instruments may affect the layout considerably and the diagram can be of great value in suggesting arrangements that simplify operation and even reduce operating expenses.

Providing for Flexibility

The question of flexibility of piping for absorbing expansion and contraction due to temperature changes is usually left for the final drawings, but time can be saved by keeping this matter in mind when the piping diagram is adjusted to suit the general plant arrangement. Expansion is sometimes cared for by using slip joints or corrugated expansion joints in the pipe lines. In this case the number and type of such joints should be indicated. More often the required flexibility is obtained by breaking up the runs of pipe with offsets and changes of direction so that expansion in one part of the system is absorbed by the bending of the next part.

The complete solution of pipe line flexibility problems is a laborious matter requiring considerable study and experience but for estimating purposes and for most commercial uses as well, there are approximate methods that can be applied rapidly and without specialized knowledge. These methods are based on the assumption that the piping system consists of straight runs connected by perfectly rigid fittings. Where cast fittings are used this theory is not far from the truth and where lines are joined by long radius pipe bends the error is not serious for the purpose intended if conservative values are used. Where forged elbows are to be welded into the line more care should be exercised and the data applying especially to these fittings should be obtained from their manufacturers. The theory is embodied in a series of formulae and curve sheets that are simple and clear;[2] they are published in part by some of the larger supply houses as supplements to their catalogs. In using the curve sheets it is not necessary to have scale drawings if the general scheme of layout is clearly understood and approximate dimensions are available. The information required can usually be reduced to the equivalent of two straight lines of piping meeting at right angles with the far ends fixed or otherwise located. The lengths of such runs can readily be estimated and the curve sheets indicate at once the flexibility that can safely be assumed. This check of flexibility may seem an unnecessary complication of work when preparing information for an estimate but it will be found that not infrequently it indicates the necessity for increasing flexibility by changes in layout that increase appreciably the cost and therefore form an essential part of the estimate.

The last stage in the layout, when the arrangement, distances and sizes have been decided, is to select the classes of material to be used. For many types of installation the materials and pressure classes are specified by codes. A good example of these is the Tentative Code for Pressure Piping, sponsored by the *A. S. M. E.* The notation of materials and classes of piping equipment completes the diagram. It is now ready for use in taking off bills of material for estimating and, if work is to proceed, it contains all the information necessary for the preparation of the formal plans and the purchase of the material.

Actual work on the preparation of flow diagrams for piping installations will demonstrate that a relatively small amount of practice enables the designer to complete such a diagram rapidly and cheaply. A surprising amount of information is contained in a small space and the work naturally follows a convenient sequence so that it is unlikely that any part will be forgotten or slighted. This feature added to the tendency to eliminate unnecessary valves and interconnections make for very real economies in design.

It will be observed that while the diagrams and data described are intended for estimating purposes, they form a complete method for design. This is as it should be, for designing and estimating are so closely related that one can hardly be carried out without at least some consideration for the other. Certainly no estimate worth having can be made without a satisfactory design to base it on and it is equally true, though not always appreciated, that a sound economic design must be based on cost figures whether these are carefully worked out and tabulated or are simply carried in the mind of the designer as the result of experience. For this reason it is well to carry out the work systematically, progressing from design to estimate and reconsidering proposed layouts in the light of cost figures. Of the several schemes of design that may be suggested at the outset of work the estimate forms a sound basis for comparison and selection although, of course, features of operation and maintenance also form essential factors.

[2]The best study of flexibility, in the author's opinion, is given in "A Manual for the Design of Piping for Flexibility by the Use of Graphs," by E. A. Wert, S. Smith, and E. T. Cope, published by The Detroit Edison Co.; see Heating, Piping and Air Conditioning, August, 1933, pp. 405-408. Also see the "Piping Handbook," by J. H. Walker and Sabin Crocker, published by McGraw-Hill Book Co., Inc.

PRACTICAL HEATING

By **Harold J. Taylor***

Boiler Ratings It is, of course, essential to know accurately the load when selecting a boiler for a given job, and in modernization work the boiler size should be figured on the basis of the radiation required for the temperature desired in the building and not on the amount of radiation which may be installed.

The transmission rate of standard cast iron radiation standing in 70 F still air is approximately 240 Btu per hr per sq ft of radiation surface. The rate increases as the temperature surrounding the radiator drops below 70 F and decreases as the temperature rises above 70 F. In average work we figure 1 lb of steam is equal to 960 Btu per hr; consequently 1 lb of steam per hr will handle 4 sq ft of radiation surface.

When pipe coil or cast iron type radiation is used, the transmission rate is approximately 30 per cent higher than for the standard column or tube type. In this type of installation we figure on the basis of tube radiation and multiply by 0.75 for the required amount of radiation to heat a given space—but for selecting boiler size the transmission rate for wall type must be used.

When blower units or blast coils are installed on a job, care should be used in determining the transmission rate. In these cases, manufacturer's temperature ratings based on both inlet (termed initial air temperature) and outlet (termed final temperature) should be referred to, using the condensate rate based on the lowest inlet temperature, remembering that 1 lb of steam or condensate is equal to 960 Btu.

Piping and Pick-Up Load

Piping load must always be figured in selecting boiler capacity; this will approximate a load of 30 per cent on jobs up to and including 1000 sq ft of radiation under standard conditions. From 1000 sq ft up to and including 2000 sq ft add 25 per cent for piping load. From 2000 sq ft up to and including 5000 sq ft, add 20 per cent for piping load.

The above figures should be used only when the piping is covered with a good grade and thickness of covering. When piping is not covered and is used to supplement the installed radiation for heating the building, pipe surface should be figured in terms of sq ft of heating surface and this load applied to the boiler, remembering that pipe will transmit approximately 30 per cent more Btu's than ordinary type cast iron tube radiation.

On large jobs it is suggested that the piping load be figured rather than estimated. It is an easy matter to compute pipe surface, especially on new work, and manufacturers will furnish data on the efficiency of pipe covering.

On installations where blower units or blast coils are used, the piping load also should be figured and not estimated, as the piping load is very little in proportion to the amount of radiation installed.

Peak load must be figured, as in the case of starting up the boiler when the radiation is cold. This load is extremely heavy and provision in boiler size must be based accordingly. This load is referred to by boiler manufacturers as ordinary pick-up load.

Generally, boiler manufacturers base their boiler capacities or ratings in terms of "Equivalent Direct Radiation" (E.D.R.) which provides for this pick up load. To define more clearly this statement, suppose a boiler develops a total output of 264,000 Btu per hr, or in other words 1100 sq ft E.D.R., burning coal at the rate of 7 lb of coal per sq ft of grate surface. If the manufacturer considers that the rate of burning coal for best efficiency is 5 lb per sq ft of grate surface he will rate this boiler for a recommended E.D.R. load of 575 sq ft.

In the above example the manufacturer has allowed a reserve in boiler capacity of 525 sq ft for handling peak load. This allowance for peak load is approximately 100 per cent over and above the suggested or recommended E.D.R. load to be connected to the boiler.

The manufacturer, as a rule, clearly defines the Btu content of the coal used in determining the rating of the boiler and these data must be adhered to. If the Btu content of the coal to be used in a specific installation is below that at which the manufacturer has rated the boiler, then an allowance must be made in boiler size. Draft conditions have a vital bearing on the capacity of boiler output, so chimney conditions should meet the requirements of the boiler manufacturer or allowances be made.

Oil Burning Boilers

When oil burning equipment is installed, a larger boiler must be selected than for coal burning. Generally, the manufacturer demands that to the total E.D.R. load for coal burning that we add 25 per cent; this extra capacity for oil burning is termed "pick up load." The length, width, and height of a boiler has a bearing on its adaptability to oil burning equipment so the oil burner manufacturer should be consulted in regard to installing a burner in a specific size boiler. The boiler capacity may be ample but due to its dimensions, it may not be of proper design. This point should be kept in mind when figuring to enlarge an old boiler for oil burning equipment.

Steel Boiler Ratings

Steel boiler ratings vary from cast iron. As a general rule, low pressure steel boilers are rated as follows:—

Hand fired coal burning boilers are rated on the basis of 14 sq ft of radiation (E.D.R.) per sq ft of heating surface (H.S.) in boiler.

Oil burning or stoker coal fired boilers are rated on the basis of 17 sq ft of radiation (E.D.R.) per sq ft of heating surface (H.S.) in boiler.

Suppose that a steel boiler has a total of 100 sq ft of heating surface and it is to be stoker or oil fired. To

*Contracting Engineer, Detroit, Mich.

Table 1—Multipliers for Heat Emission of Radiation for Air Temperatures Other Than 70 F

Temperature of air surrounding radiation	Standard column or tube radiation		Cast iron wall radiation or pipe coil	
	Steam	Water	Steam	Water
40 F	1.21	1.30	1.57	1.84
45 F	1.18	1.25	1.52	1.75
50 F	1.14	1.20	1.48	1.69
55 F	1.11	1.12	1.44	1.57
60 F	1.07	1.07	1.39	1.51
65 F	1.04	1.02	1.35	1.44
70 F	1.00	1.00	1.31	1.39
75 F	0.97	0.93	1.26	1 32
80 F	0.94	0.89	1.22	1.26

Table 2—Btu per Hr Emission of Radiation for Other Than Standard Conditions

Room temperature, F	Standard column or tube radiation		Cast iron wall radiation or pipe coil	
	Steam	Water	Steam	Water
40	290	195	377	273
45	282	188	366	263
50	274	180	356	254
55	266	173	345	244
60	257	165	334	234
65	250	158	324	224
70	240	150	314	215
75	233	143	302	205
80	224	135	292	195

Table 3—Multipliers for Temperature Range Other Than 0-70 F

Outside Temperature, F	Inside Temperature, F						
	50	55	60	65	70	75	80
+30	0.25	0.32	0.40	0.48	0.57	0.67	0.77
+20	0.38	0.45	0.54	0.62	0.71	0.81	0.92
+10	0.50	0.58	0.67	0.76	0.86	0.96	1.07
0	0.63	0.71	0.80	0.90	1.00	1.11	1.23
—10	0.75	0.84	0.94	1.04	1.14	1.26	1.38
—20	0.88	0.97	1.07	1.17	1.29	1.41	1.54
—30	1.01	1.10	1.21	1.31	1.43	1.56	1.69

find its rating, multiply 100 by 17 and the rating of boiler in sq ft of radiation (E.D.R.) will be 1700.

Water Heating Load

If an indirect hot water heater is connected to a boiler, then this load must be figured and added to the boiler size. Do not include this load when figuring for piping load as the piping involved in the installation for the heater is practically *nil*. This does not seem to be general practice among oil burner manufacturers; they invariably include the hot water load with the radiation load and then add for piping load.

For general estimating, it is practical to allow ½ sq ft of steam radiation load for each gallon of water to be heated 100 F in 3 hr. If the water is to be heated 100 F per hr, then figure 1½ sq ft of steam radiation load for each gallon of water to be heated.

To illustrate the figuring of boiler size, assume we have the following job:—

3000 sq ft of 38 in. 5 tube cast iron radiation standing in 70 F still air. All piping properly covered and surrounded by 70 F air. One 400 gal indirect hot water heater, rated to heat the water 100 F rise in 3 hr. Inside room temperature 70 F. Outside temperature 0 F. Cast iron steam boiler and oil burning equipment. Refer to Tables 1, 2, 3, 4.

3000 sq ft ..... × 1.00 ..... 3000 sq ft
3000 sq ft ..... × 0.20 ..... 600 sq ft
400 gal ..... × 0.5 ..... 200 sq ft

3800 sq ft

3800 sq ft ..... × 0.25 ..... 950 sq ft

4750 sq ft

4750 sq ft equals boiler size required based on E. D. R. load.

To illustrate further the selection of boiler sizes, assume a garage job with the following data:—

Table 4—Btu per Sq Ft per Hr With Various Water Temperatures in Radiator

Water Temperature, F	Btu per Hr
160	125
170	140
180	160
190	175
200	190
210	210
220	226

2250 sq ft of wall type cast iron radiation standing in 50 F still air. All piping properly covered and surrounded by 50 F air. One 200 gal indirect hot water heater, rated to heat the water 100 F rise in one hour. Inside room temperature 50 F. Outside temperature 0 F. Cast iron steam boiler and oil burning equipment.

2250 sq ft ..... × 1.48 ..... 3330 sq ft
3330 sq ft ..... × 0.20 ..... 666 sq ft
200 gal ..... × 1.5 ..... 300 sq ft

4296

4296 sq ft ..... × 0.25 ..... 1074 sq ft

5370 sq ft

5370 sq ft equals boiler size required based on E. D. R. load.

In the above example, 25 per cent was added for piping load to the larger amount of radiation. When piping is standing in air below 70 degrees, the transmission rate is greater, as in the case of the radiation, and the additional load must be added to the boiler load.

To illustrate the use of Table 3, assume we are figuring a heating job where the temperature inside is to be 50 F and outside temperature 0 F. We figure the amount of radiation required to heat the space to 70 F and referring to Table 3 we find under 50 F and opposite 0 F the factor 0.63.

We multiply the amount of radiation required to heat to 70 F by 0.63 and the answer will be the required amount of radiation for the 50 F temperature.

In selecting boiler size for a hot water heating installation, it is logical to figure radiation requirements in terms of sq ft of steam radiation. This figure is then converted to hot water by adding 60 per cent. This is general practice among the majority of heating contractors, for if figuring of jobs is confined to one set rule, errors are not so likely.

Under standard conditions, hot water radiation will give off 150 Btu per sq ft of heating surface per hr standing in still air with an average water temperature in the radiation of 175 F.

Recently many contractors have been laying out hot water jobs using recirculating pumps with various water temperatures other than 175 F, usually up to 220 F. As the temperature of the water is increased over the standard 175 F, less radiating surface is required to do the same amount of work but the boiler size must be based on the larger amount of radiation. Since boilers are rated on the basis of 175 F water in the radiation it will be readily understood that the selection of boiler size must be based on the actual demand upon it and not on the basis of connected sq ft of radiation.

When it is desired to figure the amount of radiation to be installed on the basis of temperatures other than 175 F, Table 4 may be used.

To illustrate use of Table 4, assume that the heat loss in a particular building totals 450,000 Btu's (450,000 divided by 150 equals 3000 sq ft of radiation) and we desire to use 200 F water in the radiation. To arrive at this required amount of radiation, 450,000 is divided by 190 and the answer is 2368 sq ft. Boiler size would be based on the 3000 sq ft load.

Heating·Piping
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Comparative Study of Combustion Results with Various Thermostats

By **Burton E. Shaw*** ***(MEMBER)*** **Des Moines, Iowa**

THERE has recently been a decided trend in the heat control industry toward a widespread application of thermostats built by different manufacturers employing artificial heating within the thermostat itself. Various ingenious methods of artificial heat application have been developed, but it is not the purpose of this paper to discuss the possible advantages or disadvantages of these devices. In the results obtained all thermostats within the same general classification or category performed to produce practically the same results. In this paper eight different thermostats of three manufacturers were investigated. Operating results were obtained on all of these thermostats, but because of limited time and test facilities, as well as the closely allied performance data which were found, certain thermostats were investigated more fully than others.

For the purpose of this paper, thermostat types *A, B, C, D,* and *E* were of artificially heated construction; type *F* was a standard precision-construction conventional unit; type *G* was of the same construction except that it employed a clock used for set-back temperatures at night. Type *H* was a clock actuated thermostat which operated at fixed time intervals to turn on the heat source (in this case an oil burner), if any room temperature drop of a fractional degree occurred at the thermostat location. Results obtained on this latter instrument as far as the temperature control was concerned, indicated that it operated over the period tested identically to that of any of the artificially heated types of thermostats arranged for so-called short cycling operation.

It is the purpose of this paper to correlate the results obtained on the various thermostats mentioned in order to compare the effect of thermostat design, operation, and location on various factors affecting flue gas loss, oil consumption, off-period stack loss, and the most important factor of all—physiological comfort. It is the further purpose of this paper to report upon the effect on oil consumption of lowering the thermostat setting during the night. It must be borne in mind that the results reported herein are those encompassed only by this investigation, and may not generally apply to other installations.

Residence A

During the heating season of 1934-35 a large well constructed eight-room frame house, located in Southwick, Mass., having a gravity warm air system installed, was thoroughly investigated. For a design inside temperature of 70 F, and 0 F outside, the calculated hourly Btu net load was 106,000 Btu. The standard Btu loss method of calculation was used to determine this value. The calculated value was later checked by computed results at 65 degree-days. In this residence calibrated thermometers were located at the floor, 30 in. and 5 ft above the floor and at the ceiling level in the living room adjacent to the thermostat. Thermometers were also occasionally read at the top of the second floor staircase in order to determine possible temperature over-run. A two bulb standard recorder was placed adjacent to the thermostat to record room temperatures. The bulbs at different times were arranged to record floor temperatures, 30 in. zone temperatures, 5 ft and ceiling temperatures. After an initial study relative to temperature variations the 24-hour chart instrument was replaced by a 7-day instrument set to record temperatures at the thermostat location. An outside temperature recorder covering a range of —30 to + 120 F was installed to record outside temperatures. No local weather bureau data were available and it was obvious that all results in order to be of value should be based on degree-days. A stack temperature recorder was located at the breeching of the furnace. A blower system was installed in conjunction with the gravity warm air furnace in order to convert the heating plant from a gravity to a forced air system. The nozzle installed in the oil burner was calibrated several times during the course of the investigation. In conjunction with the calibrated nozzle the outside 1000-gal tank was checked daily for oil consumption.

A preliminary investigation at Southwick disclosed the fact that the heating system was not in balance. In order to get a fair comparison of the various thermostats it was deemed advisable for the purposes of this paper to operate the blower at a reduced speed and to balance the system by throttling dampers located in each basement duct. This was accomplished so that a fair basis of comparison for all of the thermostats tested could be determined.

Early in the progress of the investigation it was evident that stack gas temperature alone could not be considered as a criterion of possible flue loss, even though the burner always operated at the same continuous efficiency and flue gas loss. The continuous fired carbon-dioxide concentration was set at 10 per cent with a draft of 0.02 in. water in the fire-box. In this case the setting of 10 per cent continuous carbon-dioxide concentration was selected as it is gradually becoming considered as a standard by the oil burner industry. Spot samples were taken at different intervals for the various firing conditions, but these likewise were not completely satisfactory because of personal error and other variations. It was finally decided to continually aspirate flue gases from the time the burner started until the instant it shut off, for only in this way was it possible to obtain a satisfactory cross-section of combustion results. Gas samples initially taken were analyzed for carbon-dioxide, oxygen, and carbon-monoxide by a standard Orsat apparatus.

*Research Chief, Penn Electric Switch Co.

Presented at the 42nd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Chicago, Ill., January, 1936.

However, it was evident that losses other than those that could be determined by a standard Orsat apparatus might be present, and it was therefore decided to secure a Bureau of Mines Burrell in order that an analysis could be made for the possible presence of hydrogen, as well as unconsumed hydro-carbons such as ethane and methane. Also by using the high temperature combustion method, a more accurate determination of the possible carbon-monoxide constituent could be determined. A continuous aspirating device was designed similar to the set-up as reported upon by the University of Illinois. It will be noted that electrically operated solenoid valves were arranged so that they connected to the burner stack control and permitted the introduction of a gas sample only during the burner operation.

Knowing the average stack temperature conditions as well as the average constituents of the flue gas during the *on* period of the burner, it was possible to determine the average flue loss for various methods of operation. In Southwick thermostat types *A, B, C, E, F,* and *G* were investigated. In this residence a pressure atomizing burner was employed using a calibrated nozzle delivering 3.7 gal per hour. The calculated continuous burner efficiency was 65 per cent.

Residence B

Residence *B* located in Adel, Iowa, was of practically the same construction as the one in Southwick, Mass. The investigation was continued with thermostats *D* and *H* used on the heating system which was in this case a hot water installation. Another pressure atomizing oil burner of practically the same description, but built by a different manufacturer than the one used at Southwick, was installed. This burner had a calibrated nozzle capacity of 3.16 gal per hour at a calculated efficiency of 55 per cent. The calculation of the hourly Btu requirements at Residence *B* based on 70 F inside temperature, and an outside temperature of 0 F gave the net requirement of 115,000 Btu per hour. This value was corrected to check with the actual requirements of Residence *B* as determined in the course of the investigation. In continuing the investigation in Residence *B* the main point of interest was the possible variation in results obtained by a hot water system in comparison to a warm air system. Test determinations were made in this residence in the same manner as those of Residence *A* except that in this case the burner was not set for 10 per cent carbon-dioxide concentration for continuous firing nor was an attempt made to maintain the draft constant over the fire. The installation may be considered an average one for this portion of the country, with the possible exception that no draft regulator was installed as in Residence *A*. However, it has been found that many installations like this are made each year, and it was therefore considered to be of interest to test the installation as made by an average dealer for an average application. As time permits, the investigation at Residence *B* will be continued with the oil burner set for a 10 per cent carbon-dioxide concentration, and 0.02 in. of water draft at the fire-box. At the present time on continuous firing the carbon-dioxide concentration is 5.8 per cent with the draft over the fire varying from 0.08 to 0.13 in. of water depending upon the outside temperature and wind conditions. Another reason it was considered advisable to carry on the investigations at Residence *B* under the above conditions, which might be deemed rather inefficient otherwise, was that by virtue of the results obtained at Residence *A* it was considered advisable to thoroughly study the question of *off* period sensible heat loss. This factor will be enlarged upon further in this paper.

Mounting, Location and Cycling of Thermostat

At Residence *A*, comparative studies were made of the location of thermostats at the 30 in. zone and the 5

Table 1—Fuel Consumption Comparison with Various Thermostats and Settings

Deg Days	Type	Setting [a]	Gal per Deg Day	Days
		RESIDENCE A		
33.9	*B*	*sc—N N S B*	0.53	10
50.3	*C*	*sc—N N S B*	0.54	21
25.6	*A*	*sc—N N S B*	0.56	3
36.5	*F*	*lc—N N S B*	0.51	19
24.1	*C*	*lc—N N S B*	0.52	2
		RESIDENCE B		
18.6	*E*	*sc—N N S B*	0.54	8
26.6	*H*	*sc—N S B*	0.50	2

[a] *sc*—Short cycling operation.
lc—Long cycling operation.
NNSB—No night set-back.
NSB—Night set-back.

Table 2—Fuel Consumption Comparisons with Various Thermostat Settings

Residence A: 106,000 Btu per Hour Radiation, Continuous Burner Efficiency 65 Percent

Average Deg Days	Setting	Gal per Deg Day per 100,000 Btus per Hour Net Requirements [b]	Gal per Deg Day	No Days
27.3	*sc—N S B*	0.434	0.46	3
28.7	*sc—N S B*	0.425	0.45	3
43.2	*sc—N N S B*	0.510	0.54	34
35.7	*sc/lc—N N S B*	0.500	0.53	9
55.3	*lc—N N S B*	0.480	0.51	21

Residence B: 115,000 Btu per Hour Radiation, Continuous Burner Efficiency 55 Percent

26.6	*sc—N S B*	0.435	0.50	2
18.6	*sc—N N S B*	0.470	0.54	8

[b] These average rates of consumption should not be compared to rates obtained from Fig. 1 due to the greater range of outside temperature encompassed by this table.

Table 3—Fuel Consumption Comparisons with Different Thermostat Heights

Height	Setting	Gal per Deg Day	No Days	Ave Deg Days
5 Ft	*sc—N N S B*	0.54	13	35.8
30 In	*sc—N N S B*	0.54	21	45.5
5 Ft	*lc—N N S B*	0.51	6	34.5
30 In	*lc—N N S B*	0.52	15	35.5

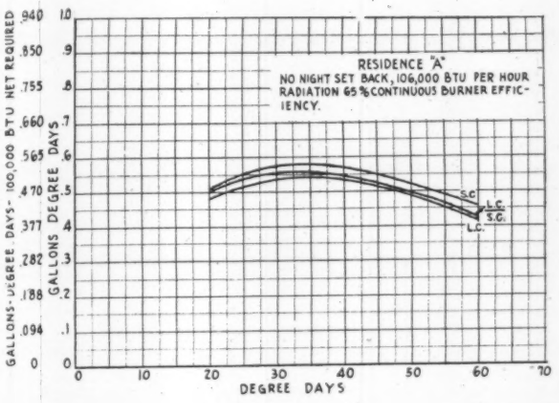

RESIDENCE "A"
NO NIGHT SET BACK, 106,000 BTU PER HOUR RADIATION 65% CONTINUOUS BURNER EFFICIENCY.
S.C.
L.C.
S.C.
L.C.
GALLONS-DEGREE DAYS - 100,000 BTU NET REQUIRED
GALLONS DEGREE DAYS
DEGREE DAYS
.940 .850 .755 .660 .565 .470 .377 .282 .188 .094 0
10 9 8 7 6 5 4 3 2 1 0
0 10 20 30 40 50 60 70

Fig. 1—Fuel consumption curves for various thermostat settings

ft zone. At Residence *B* the thermostats were only compared at the 30 in. zone.

The various thermostats tested had different means of adjusting the mechanical differential of the thermostat in order to control the burner cycle, that is, the length of the burner *on* period for any one temperature condition outside. Rather than to enumerate and compare the specific settings of the different differential adjusters of the various thermostats, it seems advisable to segregate the operation by results alone. Therefore, for the purpose of this paper, the thermostats having a setting such that the room temperature variation at the thermostat was less than 1 F were termed short cycling thermostats and were referred to by the designation, *sc*. Short cycling resulted in *line temperature control* with normal variations less than ¼ F at the thermostat location. A thermostat set so that it resulted in a 1 to 2 F maximum variation at the thermostat location was called a medium cycling thermostat and was designed by the symbols, *sc/lc*. Medium cycling resulted in normal variation not in excess of 1 F and may be termed short cycling, except for the purpose of this paper it was necessary to make a distinction between the *close temperature control* and *line temperature control* obtainable by short cycling (*sc*). Thermostats operating to maintain a maximum variation at their location of greater than 2 F are designated as long cycling thermostats and will be referred to by the symbol, *lc*. The conventional temperature recorder is scarcely more accurate than ½ F, and further many abnormal conditions such as prolonged opening of outside doors, solar radiation on the thermostat, etc., are bound to occur occasionally to upset the plans of the investigator. Hence in reporting the results of these tests the average conditions have to be considered. The term *short cycling* as previously defined may therefore be considered a normal temperature control with approximately ¼ F or less, and the term *medium cycling*—control within approximately 1 F.

Results

Thermostat Type. Based on temperature control at the thermostat location the various artificially heated thermostats performed practically alike when adjusted to give the three types of operation previously enumerated as short cycling, medium, and long cycling. Whether or not there was any relative merit to various types of thermostat construction as regards ruggedness, or snap of contacts, is beyond the scope of this paper.

Thermostat Location. Relative to oil consumption and fuel economy all results obtained indicated that there was little or no difference to be gained by the location of the thermostat (Table 3). From the standpoint of physiological comfort, however, there seemed to be a marked difference if the reactions of the author, his family, and his friends may be considered as a safe criterion. Thermometer readings showed that floor temperatures increased on the average from 1 to 5 F depending on outside weather conditions, when a 30 in. thermostat setting was used as compared to a 5 ft location. Ceiling temperatures in line with the thermostat location were increased the same amount; however, temperatures taken at the head of the second floor staircase showed very little difference. Based on the opinion of a number of people who expressed judgment on the results obtained at Residence *A* it is the author's conclusion that the location of a thermostat at approximately the 30 in. zone will give superior comfort conditions as compared to one placed in the conventional 5 ft or breathing line location. Considering the results obtained as well as experimentation with a base board mounting it is questionable whether such a low location would be satisfactory except where the residence is completely air conditioned and well insulated. A study of Table 3 shows no difference in the recorded average gallons per degree-day for Residence *A* for short cycling operation with no night set-back (*sc-N N S B*). Although the results were averaged for a different number of days and the degree-days average also was different, it is felt that the two values (gallons per degree-day) are closely comparable. Reference to Table 3 and to Fig. 1 shows that based on total averages the gallons per degree day recorded, decreased slightly from 35.8 degree-days (*sc-N N S B-5* ft) to 45.5 degree-days (*sc-N N S B*-30 in.) indicating that oil consumption for this type of operation may show a saving for the 30 in. thermostat location. It also appears from these results that the shorter the thermostat cycling the more favorable a 30 in. mounting becomes. However, there can be no doubt that on the installations investigated the *Comfort Zone* thermostat mounting resulted in no greater oil consumption and much better comfort conditions were obtained.

Length of Cycle. The effect on oil consumption of long, medium and short cycling is shown in Fig. 1, where gallons of oil consumed per day per 100,000 Btu net requirements in Residence *A* (0 vs 70 F at a calculated efficiency of 65 per cent) were plotted as ordinates against degree-days as abscissae. Also gallons of oil per degree-day were plotted as ordinates. It is evident from Fig. 1 that medium cycling as already defined in this paper will result in practically no greater oil consumption than long cycling. Straight line temperature control while the ultimate in human comfort will be somewhat less economical than long cycle control. In other words at the present stage of the art, and considering the type of oil burners investigated, *line temperature control* with about ¼ F maximum variation will be more expensive depending upon outside weather conditions, than medium or long cycle operation. The average oil consumption will be less than 2 per cent greater for

medium cycling than for long cycling. The value for straight line temperature control will be slightly more than this value. Based on Fig. 1 there seems to be little difference between medium cycling control that may readily be obtained with the new type of artificial heating thermostats as compared with the long cycling method of operation obtained with former conventional thermostats. In fact at Residence *A* as outside temperature conditions became more severe with an increasing number of degree-days the medium cycle operation holding the average temperature within a variation of less than 1 F closely approached the economy of the conventional long cycle thermostat operation. Investigation was made of the cause of extra loss on very short cycling operation with the results as shown in Tables 4 and 5. It is evident from Table 4 as well as Fig. 8 that the total flue loss increases directly with the length of cycling in the range tested. Hence, considering all radiation loss as practically a constant, greater economy with short cycling would be expected if it were not for the higher *off* period loss as shown in Table 5. *Base loss* contributing as it does to both radiation and convection losses was kept at a minimum with insulation behind the bricking and the use of light weight porous insulating brick. Convection effects were undoubtedly reflected in a somewhat higher sensible heat dry stack loss during the *on* period as well as a higher sensible heat loss during the *off* period. The *off* period loss is controllable and more cognizance should be given to this factor. The *off* period losses were calculated as shown in Appendix *A* and will be more fully discussed later. The values calculated by this method check closely with the total over-all loss indicated by the oil consumption data, and the net radiation requirements of the house. They are, therefore, believed to be close to the actual conditions existing and serve their purpose of indicating the variation of *off period* loss with length of cycle and outside temperature conditions. Table 5 also analyzes the unconsumed flue gas loss indicating that it is greater for shorter cycling, but the per cent variation is small. Furthermore the lower average stack gas temperature counteracts this slight increase to maintain the total loss less for short cycling. Fig. 2 shows degree-days as ordinates plotted against gallons per day as abscissae for the various types of thermostat operation. The curves indicate little variation between long cycling and medium cycling operations.

Table 1 shows the various types of thermostats with different settings, and the gallons per degree-day recorded at Residence *A*, for the number of days in which the investigations were made. In Fig. 1 all of the thermostats operated at their day settings continually 24 hours a day; and no night set-back was used, hence the designation *N N S B*. It is to be noted that for similar settings the results obtained on each of the thermostats were quite consistent considering variation in degree-days and the number of days in which the values were averaged. Table 1 also shows a small saving in oil consumption for long cycling vs short cycling operation.

Table 2 compares various types of thermostat operation on the different thermostats, with gallons per degree-day, gallons per degree-day per 100,000 Btu net heating requirements at Residence *A*, and the number of days during which each instrument was tested. Table 2 also shows a group of values obtained at Residence *B* on a

Table 4—Flue Losses with Different Thermostat Settings

Setting	Percent Loss	No Days	Ave Deg Day
sc	25.3	4	23
lc/sc	27.6	4	21.3
lc	30.5	7	21.9

Table 5—Stack Gas Loss Averages

Thermostat Setting	*sc*	*sc/lc*	*lc*
Ave Deg Days	25.2	20.2	26.3
Number of Days	4	4	7
Stack Temperature			
Burner Off	243 F	183 F	189 F
Burner On	309 F	385 F	445 F
Carbon-Dioxide	4.7%	5.2%	5.3%
Oxygen	11.8	11.5	11.9
Flue Gas Losses			
Moisture	7.61	7.91	8.02
Unconsumed			
Carbon-Monoxide	0.70	0.19	0.09
Methane	0.78	0.23	0.016
Ethane	1.18	0.12	0.06
Hydrogen	0.25	0.27	0.32
Total Unconsumed	2.91	0.71	0.486
Dry Flue Gas Loss	14.8	18.2	21.5
Total Flue Gas Loss	25.3	27.2	30.4
Off-Period Loss	35.0	27.6	25.6
Total Loss	60.3	54.8	55.3
Gal Fuel per Deg Day	0.55	0.50	0.52

hot water installation over a period of eight days in which thermostat *D* was set for short cycle operation with no night set-back. It will be noted that the gallons per degree-day were lower as recorded at Residence *B* than the gallons per degree day at Residence *A* (*sc-N N S B*), however the degree-days were also lower. The gallons per degree day per 100,000 Btu net requirements at Residence *B* were less than Residence *A* with a thermostat setting for no night set-back showing some increased efficiency in the hot water plant over the warm air installation even though the actual flue gas efficiency of the burner at Residence *B* was less than it was at Residence *A*. This may also be explained by a variation in the number of degree-days in each case (Fig. 9). These data are not to be construed as indicating that the hot water plant is intrinsically more efficient than the warm air system; for there are several other factors involved. Actually the hot water installation was more efficient than the old converted warm air system used at Residence *A*.

Night Set-Back

Relative to the effect of night set-back on oil consumption Table 2 shows a marked saving in oil consumption based on gallons per degree-day for night set-back designated *N S B*. This saving was 7 per cent for short cycle operation at Residence *B* for approximately 22 degree-days, and nearly 12 per cent for long cycle operation at Residence *A* compared, however, for 28.7 degree-days against 35.3 degree-days. Additional saving for long cycle operation can be explained by lower *off* period losses. Table 9 shows the effect of night set-back on average stack gas temperatures for various types of operation.

Table 6—Off-Period Losses No Night Set-Back, 20 Degree-Days

Thermostat Setting	*sc*	*lc/sc*	*lc*
Ave Temperature T (F)	273	185	185
Velocity of Air (ft per sec)	8.2	7.8	7.8
Volume (cu ft per sec)	2.87	2.73	2.73
Time off (sec)	73,600	74,600	73,000
Volume (cu ft per day)	210,000	204,000	199,000
Specific Gravity	0.00086	0.00100	0.00100
Weight (lb per day)	11,250	12,700	12,500
Temperature Difference (T-50 F)	223	135	135
Btu per Day	626,000	430,000	423,000
Ave Deg Days	23.0	21.3	21.9
Fuel (lb per day)	92.2	80.5	84.6
Btu Lost per lb Fuel	6,790	5,350	5,000
Per Cent Off—Period Loss	35.0	27.6	25.6
Btu Lost per Deg Day	27,200	20,200	19,200

Table 7—Off-Period Losses No Night Set-Back, 40 Degree-Days

Thermostat Setting	*sc*	*lc/sc*	*lc*
Ave Temperature T (F)	390	251	192
Velocity of Air (ft per sec)	9.7	8.1	7.73
Volume (cu ft per sec)	3.40	2.84	2.72
Time Off (sec)	41,200	51,000	59,160
Volume (cu ft per day)	140,000	145,000	161,000
Specific Gravity	0.00075	0.00090	0.00095
Weight (lb per day)	6,550	8,130	9,520
Temperature Difference (T-50 F)	340	201	142
Btu per Day	555,000	410,000	338,000
Ave Deg Days	39.8	40.7	40.7
Fuel (lb per day)	181	163.0	151.0
Btu Lost per lb Fuel	3,060	2,510	2,240
Per Cent Off—Period Loss	15.8	13.0	11.6
Btu Lost per Deg Day	13,900	10,100	8,300

Table 8—Off-Period Losses No Night Set-Back, 60 Degrees-Days

Thermostat Setting	*sc*	*lc/sc*	*lc*[c]
Average Temperature T (F)	465	299	235
Velocity of Air (ft per sec)	11.0	9.2	8.4
Volume (cu ft per sec)	3.85	3.22	2.94
Time Off (sec)	32,200	43,800	46,200
Volume (cu ft per day)	124,000	141,000	136,000
Specific Gravity	0.00069	0.00084	0.00090
Weight (lb per day)	5,340	7,400	7,610
Temperature Difference (T-50 F)	415	249	185
Btu per Day	555,000	461,000	352,000
Ave Deg Days	60.2	62.7	50.3
Fuel (lb per day)	193	195	169
Btu Lost per lb Fuel	2,890	2,360	2,100
Per Cent Off-Period Loss	14.9	12.2	10.8
Btu Lost per Deg Day	9,200	7,530	7,000

[c] *lc*—50 Deg Days.

Table 9—Effect of Night Set-Back on Stack Temperatures

	N S B Temp F	Ave Deg Days	*N N S B* Temp F	Ave Deg Days.
Burner *off*:				
sc	213	26.5	273	23.8
lc/sc	178	17.0	185	21.3
lc	166	27.0	185	24.0
Burner *on*:				
sc	346	26.5	273	23.8
lc/sc	393	17.0	283	21.3
lc	415	27.0	456	24.0

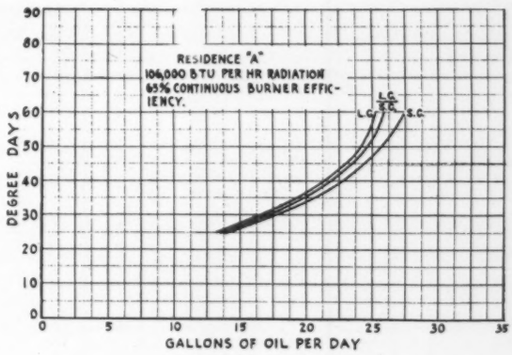


Fig. 2—Various thermostat fuel consumption curves plotted against degree-days

Flue Loss

The calculated *off* period sensible heat loss has been shown in Tables 6, 7, and 8 for each of the types of operation and it is to be noted that they are highest for short cycle operation, and lowest for long cycle operation. If these latter calculated losses are considered in conjunction with the flue-gas loss during the *on* period, the total loss assumes a high value. The calculated losses, however, compare with the results actually obtained and it would, therefore, seem that *off* losses assume a larger value than various investigators have previously reported. These losses are controllable by application of air inlet dampers to be shut during the *off* period of the burner, or by use of a boiler flue-gas discharge damper controlled by the operation of the burner. It is apparent from this investigation that much may yet be accomplished toward increased economy in the operation of oil burning appliances.

Tables 6, 7, and 8 show calculated *off* period losses considering no night set-back for 20, 40 and 60 degree-days respectively. These calculations were based on an average gas temperature as shown in the first column of the table, on an average outside temperature based on the various degree-days, with a total chimney height of 30 ft, considering an 8 in. flue pipe and with a draft based on the calculated average draft over the fire box as shown in Fig. 3, where draft in chimney and stack was plotted vs degree-days for long, medium and short cycling. Fig. 4 shows the calculated stack velocity in feet per second vs degree-days for different types of thermostat operation.

It is evident that the *off* period loss increases inversely as the length of the burner cycle, and that the *off* period loss for any one type of thermostat operation decreases with an increase in degree-days. This latter condition is further shown in Fig. 6 showing thousands of Btu per degree-day *off* period loss plotted vs degree-days.

Table 9 shows the effect of night set-back on average temperatures during the burner *off* period as well as the burner *on* period. Table 9 is compared for similar weather conditions of approximately 20 degree-days. Weather conditions at both Residences *A* and *B* throughout the heating season averaged between 20 and 30 degree-days per day.

In an attempt to more closely study the *off* period sensible heat losses Fig. 3 was drawn indicating actual

conditions obtainable at Residence *A* showing variations in chimney draft in inches of water plotted against degree-days for long and short cycling.

Fig. 4 indicates the average velocity of air traveling through the stack during the *off* period at Residence *A* based on long, medium, and short cycle operation, where velocity is plotted against degree-days. Fig. 4 is based on the draft over the combustion chamber as determined from Fig. 3 as well as average temperature conditions obtained for short and long cycling for the various degree-days.

Actual conditions obtained at Residence *B* are shown in Fig. 5 with no draft adjuster installed. It is to be noted that the combustion chamber draft is higher than for Residence *A*, which was adjusted for 0.02 draft, and that the *off* period losses for Residence *B* will be higher than for Residence *A*. The *off* period losses as determined for Residence *A* are shown in Tables 6, 7, and 8, and are based on conditions prevailing at Residence *A* with the standard setting of 10 per cent carbon-dioxide continuous fired concentration. However, Residence *A off* period losses as shown in Tables 6, 7, and 8 are corrected for the variation in combustion chamber draft as shown in Fig. 3. Based on considerable test data available Fig. 3 indicates a close approximation of the draft changes that may be expected over the combustion chamber for variations in external weather conditions when a conventional stack draft damper is employed.

Actual draft and stack temperature conditions prevailing at Residence *B* are shown in Fig. 5 on a 40 degree-day (average outside temperature 25 F) with these various factors plotted against time in minutes during one complete burner cycle. From these curves it is evident that a high combustion chamber draft was prevalent for this installation when no draft regulator was employed. Although these conditions may not be considered as an average, there are many installations where no draft controls are used, and it is possible that in these installations the *off* period loss is greater than that shown in Tables 6, 7, and 8 calculated for Residence *A*.

Average stack temperatures during *off* period and length of time *off* plotted for long and short cycles of operation against degree-days at Residence *A* are illustrated in Fig. 7. The average stack temperature during *off* period for long cycle firing based on degree-days is lower than the average temperature during *off* period for short cycle firing. It is apparent from these curves that the time *off* for the same number of degree-days is greater for long cycle firing than with short cycling. Furthermore the time *off* decreases with an increase in degree-days to a point where the long cycle and short cycle curves converge. Zero time *off*, or continuous operation will occur at the number of degree-days at which the burner capacity is set to deliver 70 F inside temperature for the degree-day equivalent outside temperature. The temperatures plotted in Fig. 7 are the temperatures in the stack during the *off* period, thus indicating a reason for the greater *off* period loss for short cycle operation than for long cycling. The difference in time *off* for the same number of degree-days for both long and short cycling is due to the fact that there is a higher over-all efficiency for long cycle operation because of the

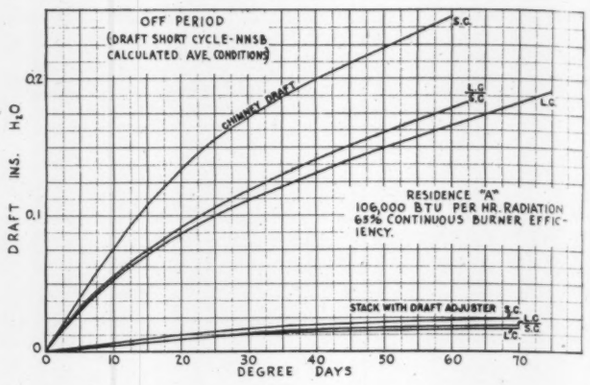


Fig. 3—Chimney draft curves for various thermostat settings, *Off* period operation

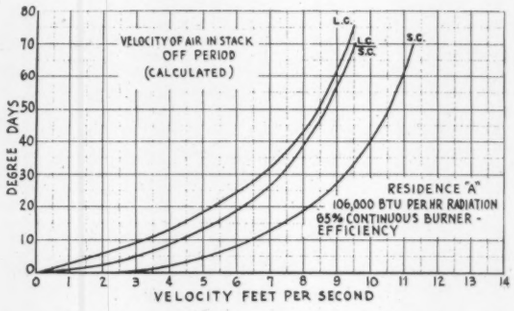


Fig. 4—Velocity of air in stack for *Off* period operation with various thermostat settings

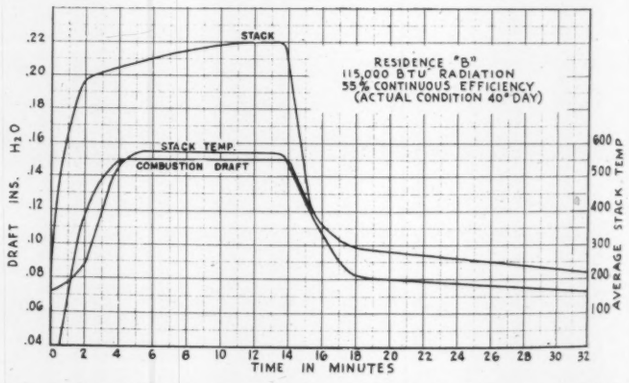

STACK
RESIDENCE "B"
115,000 BTU RADIATION
55% CONTINUOUS EFFICIENCY
(ACTUAL CONDITION 40° DAY)
STACK TEMP.
COMBUSTION DRAFT
DRAFT INS. H₂O
.22 .20 .18 .16 .14 .12 .10 .08 .06 .04
AVERAGE STACK TEMP
600 500 400 300 200 100
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
TIME IN MINUTES

Fig. 5—Stack temperatures and combustion draft for a period of operation on a 40 degree-day

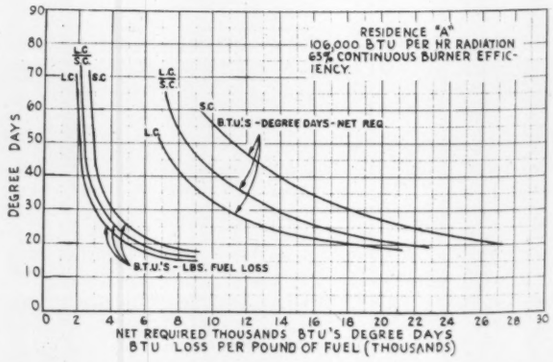

RESIDENCE "A"
106,000 BTU PER HR RADIATION
65% CONTINUOUS BURNER EFFICIENCY.
L.C.
S.C.
L.C.
S.C.
L.C.
S.C.
L.C.
B.T.U.'S - DEGREE DAYS - NET REQ.
B.T.U.'S - LBS. FUEL LOSS
DEGREE DAYS
90 80 70 60 50 40 30 20 10 0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
NET REQUIRED THOUSANDS BTU'S DEGREE DAYS
BTU LOSS PER POUND OF FUEL (THOUSANDS)

Fig. 6—Net Btu requirements and fuel losses plotted against degree-days

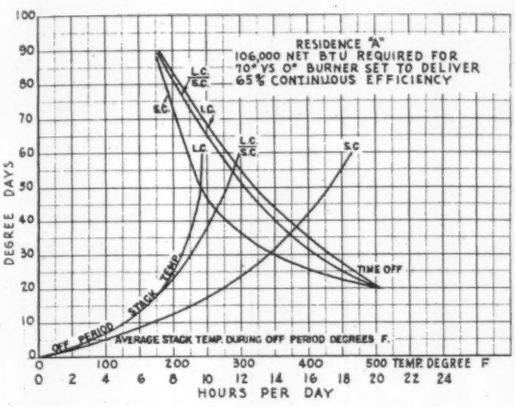


Fig. 7—*Off* period stack temperatures and periods of burner operation plotted against degree-days

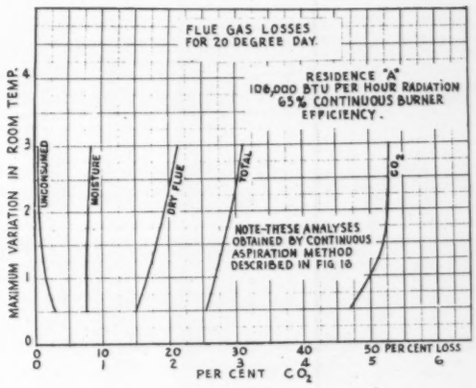


Fig. 8—Curves showing flue gas losses for a 20 degree-day

greater *off* period loss with short cycling operation.

A 7-day chart at Residence *A* is illustrated in Fig. 9 indicating long cycle operation. From this chart it is interesting to note the temperature over-run which occurred at 2 p. m. on Thursday when the thermostat setting was changed to increase the temperature from 68 F to an average of 73 to 74 F. The temperature actually increased to 76 F resulting in a temperature over-run of 2 F and a further over-run may be noted at 3 p. m. on Sunday when a similar condition occurred.

Fig. 10 shows a 24-hour chart at Residence *A* of medium cycle operation.

A 24-hour chart with short cycle operation at Residence *B* is illustrated in Fig. 11. The length of the burner *on* period is indicated at the outer circumference of the chart by a drop in the exterior line drawn by a pen actuated from a relay wired to the burner motor. It may be noted from this chart that practically straight line temperature conditions were obtainable. The deviations occurring at 8:30 a. m. and at 4:20 p. m. were caused by prolonged opening of an outside door. As regards human comfort there is little comparison between the results shown in Figs. 9, 10, and 11. It is apparent from the results obtained that short cycle operation gives the ultimate in comfort in the room where the thermostat is located. Of course it is evident that extremely close temperature control at the location of the thermostat without proper balance and distribution of the heating system may result in unsatisfactory heating at remote points. If a system is out of balance it is frequently desirable to forego the comfort obtainable in the living room or at the thermostat location in order that better distribution may be accomplished, and in such cases longer cycling would have to be resorted to. A thermostat should not be expected to rectify major heating plant faults, but it may assist in their correction, and it should be recognized that balanced plants are desirable in order that the ultimate in comfort may be obtained with artificially heated thermostats.

Figs. 12, 13, and 14 give a comparison of stack temperatures for long, short, and medium cycling for 20 degree-day operation. Fig. 12 shows the stack temperature condition existing for long cycle operation, and an average outside temperature of 45 F (20 degree-days). The stack temperature conditions for short cycle and 20 degree-day operation are illustrated in Fig. 13. Fig. 14 shows medium cycling operation for a 20 degree day.

Fig. 9—Residence *A* inside temperatures, *LC* operation

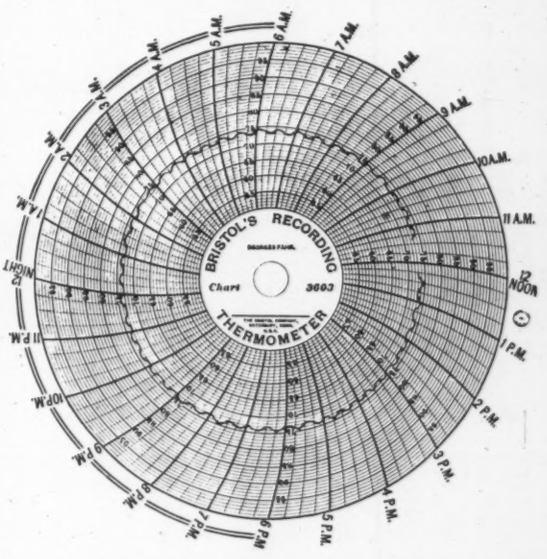


Fig. 10—Residence *A* inside temperatures, *LC/SC* operation

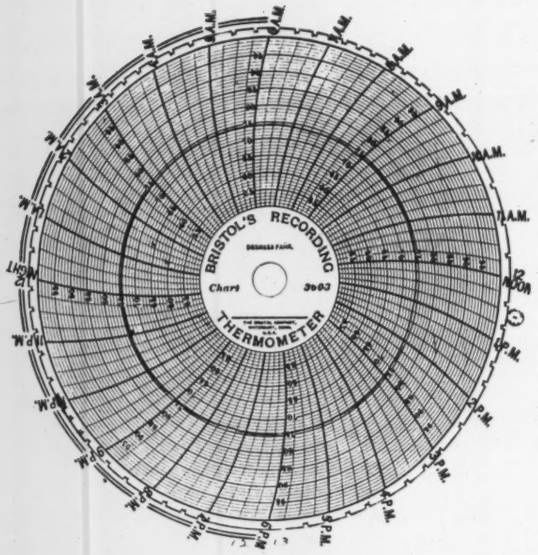


Fig. 11—Residence *B* inside temperatures, *SC* operation

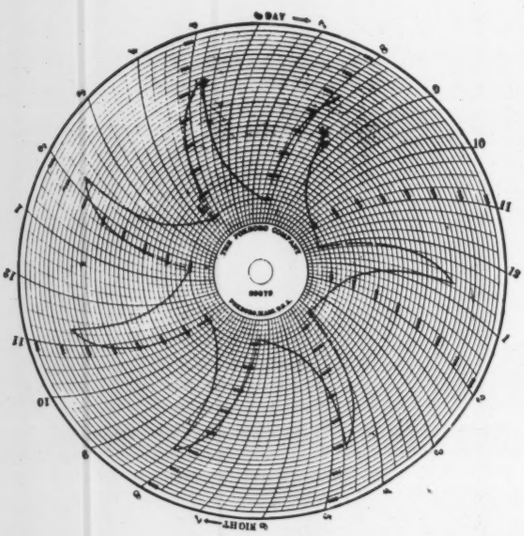


Fig. 12—Residence *A* stack temperatures, LC-NNSB, 20 degree-days. Average temperature: *On* 461; *Off* 188

Morning Overshooting

The effect of the type of thermostat operation on morning overshooting for Residence *A* using a converted forced warm air system is illustrated in Fig. 15. On a 40 degree-day for short cycling operation Fig. 15*a* shows no overshooting occurred after a night set-back of 6 F on a 17 degree-day, and Fig. 15*b* shows 1-F overshooting. High speed blower operation (increased air circulation, and hence less *stratification*) tended to reduce the room temperature variation from 1 to ½ F as indicated in Fig. 15*b*. Good long cycle operation with only 2 F overshooting on a 25 degree-day, is shown in Fig. 15*c*, however, overshooting as high as 4 F was experienced with this type of operation.

The gas sampling apparatus employed for the determination of flue gas samples is described in Fig. 16.

Table 9 shows the effect of night set-back on stack temperatures for a 20 degree-day. The stack temperature during the *on* period averages lowest with the shortest cycle, both for night set-back and no night set-back. However, the average stack gas temperature is lower with no night set-back than it is with night set-back with the same outside temperature conditions. Stack temperatures during the *off* period of the burner are higher for the shortest cycling and are also higher for no night set-back than they are for night set-back.

The higher stack temperatures during the *on* period where night set-back was employed is occasioned by the fact that in the morning when the room thermostat calls for burner operation to bring the room back to normal, the stack temperature rises above its normal conditions, thus giving in the 24-hour period a higher temperature average for night set-back than for no night set-back. This average temperature in the stack does not prevent more economical operation with night set-back conditions

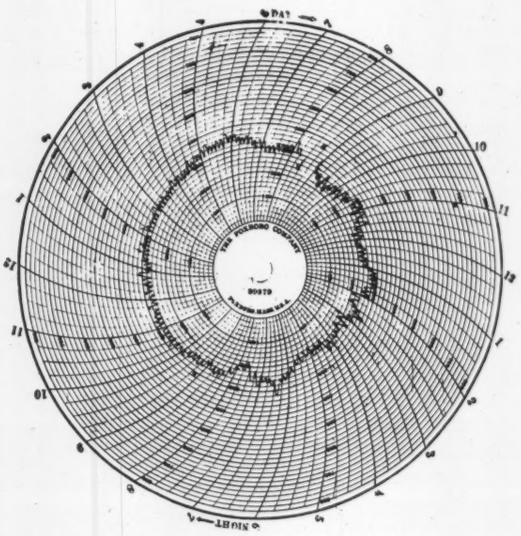


Fig. 13—Residence *A* stack temperatures, *SC-NNSB*, 20 degree-days. Average temperature: *On* 264; *Off* 264

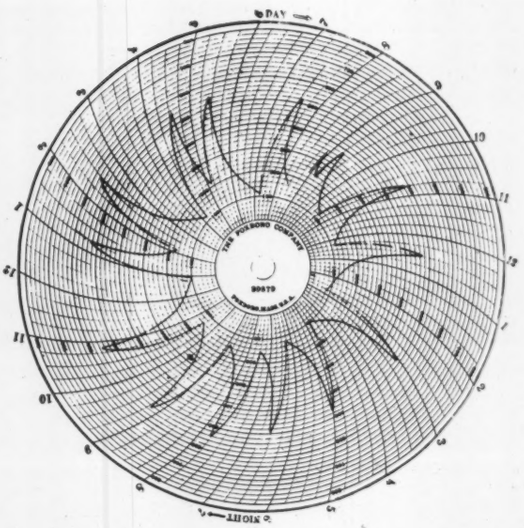


Fig. 14—Residence *A* stack temperatures, *LC/SC—NNSB*, 20 degree-days. Average temperature: *On* 379; *Off* 208

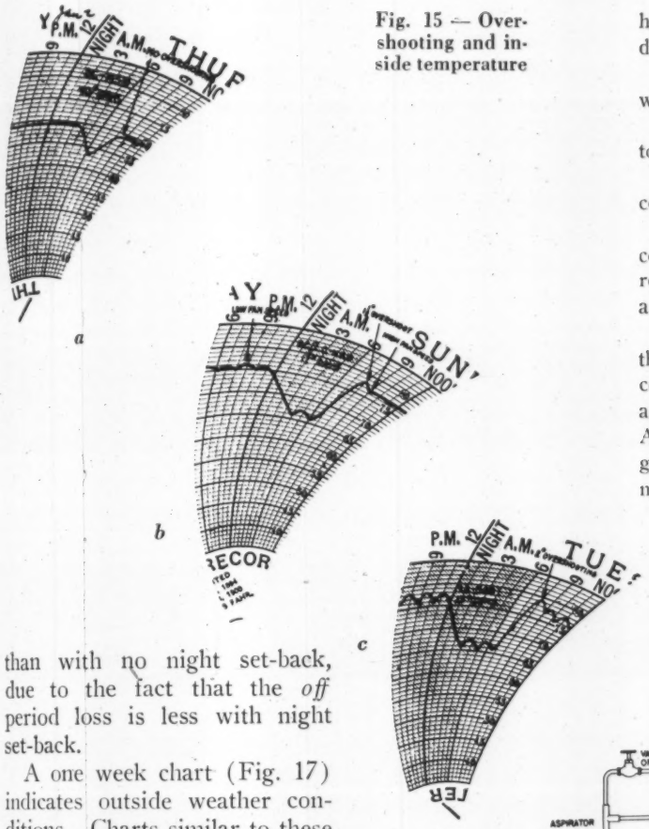


Fig. 15 — Overshooting and inside temperature

than with no night set-back, due to the fact that the *off* period loss is less with night set-back.

A one week chart (Fig. 17) indicates outside weather conditions. Charts similar to these were used to determine the number of degree-days.

Conclusions

The following conclusions seem to be justified from the results obtained:

1. There was practically no difference between the economy of *Close Temperature* control and that obtainable with conventional *Wide Temperature* operation.

2. From the standpoint of comfort, *Line* or *Close Temperature* control obtainable with either short or medium cycling was more desirable than conventional thermostat control with its attendant greater temperature variation.

3. The average flue loss for short cycle operation was less than medium cycle operation, which was less than long cycle operation. The average *off* period loss for short cycle operation was greater than that for medium cycle operation which was slightly greater than that for long cycle operation.

4. It is apparent that if designers of burners and boilers, as well as control equipment, concentrate their efforts towards the elimination of *off* period loss, short cycle operation should be the most economical.

5. From the viewpoint of economy there was little difference between a 30 in. thermostat mounting and a 5 ft mounting, but from the standpoint of human comfort the 30 in. mounting is more desirable.

6. Although unconsumed hydrogen and hydro-carbon loss was slightly greater for short cycle than for long cycle operation, there was little difference between the two types and the little difference which existed was more than offset by the lower sensible heat loss during the *on* period, because of lower temperatures resulting from short cycle operation.

7. At the two installations investigated night set-back of approximately 6 F resulted in a fuel saving dependent upon the type of thermostat operation and the degree-days. In general the saving was between 8 and 10 per cent. This is considered higher than may normally be expected.

8. Morning overshooting was least with the artificially heated thermostats and was to a minor extent dependent on degree-days.

9. It was possible to obtain short, medium, or long cycling with any of the artificially heated thermostats tested.

10. The artificially heated thermostats tested were superior to the conventional type.

11. Type *G* time interval clock actuated type of thermostat compared favorably with the artificially heated type.

12. Because of decreasing time *off* as outside temperature conditions became colder, greater economy of fuel consumption resulted, and therefore oil consumption per degree-day was not a constant.

13. Perhaps the most important conclusion to be drawn from this investigation relates to the inherent advantages of short as compared to long cycle operation. The tests indicated that short and medium cycling resulted in greater room comfort conditions. Also because of lower flue gas losses, short cycle operation would give the ultimate in economy of operation if present designs permitted more complete control of *off* period losses. Medium cycling (*Close Temperature* control within about 1 F room temperature variation) will result in but very little increased oil consumption and yet affords the maximum possible in room comfort.

Acknowledgment

The author is indebted to J. Smith, Research Engineer of the Gilbert & Barker Manufacturing

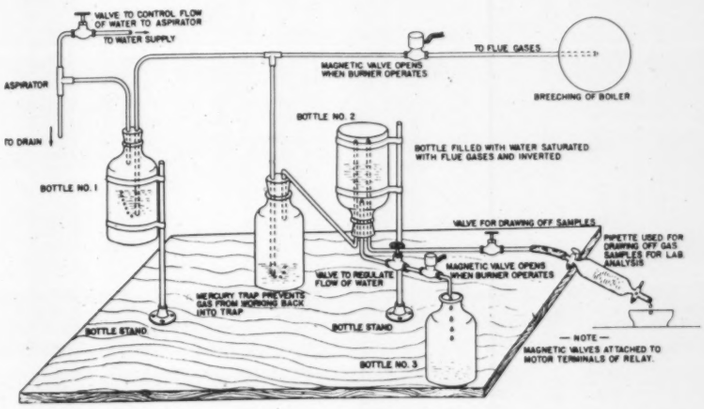

VALVE TO CONTROL FLOW OF WATER TO ASPIRATOR
TO WATER SUPPLY
TO FLUE GASES
MAGNETIC VALVE OPENS WHEN BURNER OPERATES
BREECHING OF BOILER
ASPIRATOR
TO DRAIN
BOTTLE NO. 2
BOTTLE FILLED WITH WATER SATURATED WITH FLUE GASES AND INVERTED
BOTTLE NO. 1
VALVE FOR DRAWING OFF SAMPLES
PIPETTE USED FOR DRAWING OFF GAS SAMPLES FOR LAB ANALYSIS
MAGNETIC VALVE OPENS WHEN BURNER OPERATES
VALVE TO REGULATE FLOW OF WATER
MERCURY TRAP PREVENTS GAS FROM WORKING BACK INTO TRAP
BOTTLE STAND
BOTTLE STAND
BOTTLE NO. 3
— NOTE —
MAGNETIC VALVES ATTACHED TO MOTOR TERMINALS OF RELAY.

Fig. 16—Continuous aspiration method of collecting flue gas samples during burner operating period

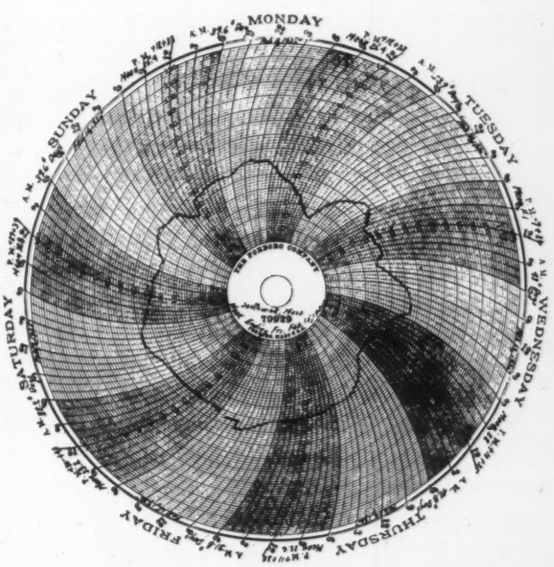


Fig. 17—Residence *A* outside temperature chart

Company, Springfield, Mass., for his able assistance in performing most of the field work encompassed by this report as well as his advice in its compilation. The author also wishes to give credit to LaVerne Lyon, Research Engineer at the Penn Electric Switch Co., for his painstaking care in the preparation of this manuscript.

Appendix

A group of sample calculations are included in this paper under Appendix *A*. The method of flue gas analysis used is discussed in Appendix *B*, and appendix *C* gives the average fuel analysis used in this investigation.

Appendix A

1. Off Period Loss

Assumptions:

Height of Stack = 30 ft

Diameter = 8 in. iron pipe

Draft vs Deg Day Curve

a. 20 Deg Day, Temperature in Stack = 273 F *sc—NNSB*, Draft = 0.015 in. H_2O, ρ = (0.00086) 62.3 (from graph)

Where:

$\Delta\rho$ = Draft (in. H_2O)

U = Velocity (ft per sec)

ρ = Density (lb per cu ft)

d = Diameter (ft)

D = Diameter (in.)

g = 32.2

$\frac{s}{z}$ = Specific gravity / Relative viscosity = 0.037

f = Friction

$$\Delta\rho\dagger = \frac{2fL\rho U^2}{gd}$$

$$U^2 = \frac{gd\Delta\rho}{2fL\rho}$$

$$U = \sqrt{\frac{gd\Delta\rho}{2fL\rho}}$$

Assume $f = 0.0015$

$$U = \sqrt{\frac{(0.015)\ (32.2)\ (0.67)}{2\ (0.0015)\ (0.00086)\ (62.3)\ (30)}}$$

$$= \sqrt{67.3}$$

= 8.21 ft per sec.

Check friction assumption.

$$(DU)\left(\frac{s}{z}\right) = (8)\ (8.21)\ (0.037) = 2.43$$

(From graph: $f = 0.0016$)

b. Volume per sec = (U) (Area) = (8.21) (πr^2) = (8.21) (3.14) $(4/12)^2$ = 2.89 cu ft per sec.

c. Volume per day = (2.89) (Time Burner Off) = (2.89) (73,600 sec) from stack temp. chart) = 213,000 cu ft per day.

d. Weight per day = Density × Volume = (0.00086) (62.3) (213,000) = 11,450 lb per day.

e. Btu per day = (Temp Increase) (Specific Heat) (lb) (273-50) (0.25) (11,450) = 640,000 Btu per day.

f. Btu lost per Deg Day = $\frac{\text{Btu per day}}{\text{Deg Days}} = \frac{640{,}000}{20}$ = 32,000 Btu.

2. On Period Loss

Data:

Average Stack Temperature = 192 F

a. Dry flue gas loss.

(1) Weight dry flue gas per lb of fuel

$$W = \frac{11\,CO_2 + 8\,O_2 + 7\,(N_2 + CO)}{3\,(CO_2 + CO)} \times C + \frac{S}{1.83}$$

$$= \frac{11\ (5.8) + 8\ (10.1) + 7\ (82.24 + 0.1)}{3\ (5.8 + 0.1)} \times 0.861 + \frac{0.0006}{1.833} = 35 \text{ lb per lb of fuel.}$$

(2) Heat lost per lb of fuel

= W (Specific Heat) (Stack Temp-Temp of entering air) = (35) (0.25) (390-50) = 2,989 Btu per lb.

b. Loss due to hydrogen in fuel.

$L_h = H \times 9\ [(212 - T_f) + 970.4 + 0.48\ (T_s - 212)]$

Where:

H = per cent H in fuel by weight.

T_f = Temperature of entering fuel.

T_s = Temperature of flue gases.

L_h = (0.139) (9) [(212-50) + 970.4 + 0.48 (390-212)]

= 1,520 Btu per lb fuel.

c. Loss due to incomplete combustion of carbon.

$$LCO = \frac{CO}{CO_2 + CO} \times C \times 10{,}160$$

$$= \frac{0.1}{5.8 + 0.1} \times 0.139 \times 10{,}160$$

= 17.5 Btu per lb fuel.

d. Loss due to Methane, Ethane, Hydrogen in flue gas.

(1) Change per cent by volume to per cent by weight.

Flue Gas Analysis	By Volume Per cent	Molecular Weight	V × M	Per cent by Weight	V × M / 2887.8
CO_2	5.8	44	255.0		
O_2	10.1	32	323.0		
H_2	0.5	2	1.0	$\frac{1}{2887.8}$	= 0.000345
CO	0.1	28	2.8		
C_2H_6	0.13	30	3.9	$\frac{3.9}{2887.8}$	= 0.00135
CH_4	0.13	16	2.1	$\frac{2.1}{2887.8}$	= 0.00072
N_2	82.24	28	2300.0		
	100.00		2887.8		

(2) $\frac{(\%\text{ Weight})\ (\text{Pounds flue gas})}{(\text{Pounds fuel burned})} \times \frac{(\text{Btu})}{\text{lb}} = \frac{\text{Btu lost}}{\text{Pounds fuel burned}}$

Ethane 0.00135 × 35 × 20,400 = 9.6 Btu per lb.

Methane 0.00072 × 35 × 21,600 = 5.4 Btu per lb.

Hydrogen 0.000345 × 35 × 51,700 = 6.25 Btu per lb.

3. Chimney Draft

Draft equals difference in pressure of two equal columns of air, one at stack temperature and the other at outside temperature.

$$\text{Pressure} = \frac{\text{Weight}}{\text{Area}}$$

Weight = Volume × Density

$Wt = V\rho_1$

$Wt_2 = V\rho_2$

$$\frac{Wt_1 - Wt_2}{A} = \frac{V\rho_1 - V\rho_2}{A}$$

$$= \frac{V}{A}(\rho_1 - \rho_2) = H\ (\rho_1 - \rho_2)$$

Where: H = height in feet

At 20 Deg Day *sc—NNSB* Ave Stack Temperature = 273 and H_p = draft in lb per sq ft.

F *off* period. Outside Temperature = 45F

$\rho_1 = 0.00122$

$\rho_2 = 0.00085$

$\rho_1 - \rho_2 = 0.00037$

H_p = (30) (62.3) (0.00037) = 0.693 lb per sq ft

= 0.134 in. H_2O

†From: Haslam and Russell, Fuels and Their Combustion.

Appendix B

Flue Gas Analysis:

Carbon-dioxide, oxygen and carbon-monoxide were determined in the usual manner using an Orsat apparatus. The carbon-monoxide was then checked by oxidation—slow combustion in oxygen in the presence of a glowing platinum coil. The carbon-dioxide was absorbed with potassium hydroxide.

Hydrogen was similarly found by slow combustion in oxygen in the presence of a glowing platinum coil. Since the water formed was negligible, the hydrogen was equal to the contraction in volume caused by its oxidation.

Methane and Ethane were also determined by slow combustion in oxygen in the presence of a glowing platinum coil. Both contraction in volume due to combustion and volume of carbon-dioxide formed was determined as Methane and Ethane were present together.

Appendix C

Fuel Analysis	Per Cent by Weight
(Table 1, *American Oil Burner Association*, Handbook of Oil Burning.)	
Carbon	86.1
Hydrogen	13.9
Oxygen and Nitrogen	1.6
Sulphur	0.06

Density: 7.43 lb per gallon.

Btu Content: 19,350 Btu per gallon.
144,000 Btu per pound.

Award of Lamme Medal

Announcement has just been made of the award of the 1935 Lamme Medal of the *American Institute of Electrical Engineers* to Dr. Vannevar Bush, vice-president of the Massachusetts Institute of Technology and dean of the School of Engineering, "for his development of methods and devices for application of mathematical analysis to problems of electrical engineering." Presentation of the medal and certificate to Dr. Bush will be made at the annual summer meeting of the *A. I. E. E.*, which is to be held in Pasadena, Calif., June 22-26, 1936.

Dr. Bush is noted for his achievements in electrical research and contributions to technical education. He is a native of Massachusetts, where he now makes his home at Belmont. In 1913 he was graduated from Tufts College and in 1916 he was awarded the degree of doctor of engineering from Harvard University and Technology. In 1932 he received the honorary degree of doctor of science from Tufts College, of which he is now a member of the board of trustees.

Dr. Bush has long been interested in the design of analyzing instruments and for one development he was awarded the Levy Medal of the Franklin Institute in 1928. He directed the design and construction at M. I. T. of the network analyzer, a device for accurately reproducing and studying the operating characteristics of power networks under satisfactory conditions. He has also carried on important studies of transients in machines and inter-connected power systems, and is known for his contributions to the development of thermionic and gaseous conduction tubes.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Co., to provide for the annual award of a gold medal, together with a bronze replica, to a member of the *A. I. E. E.*, "who has shown meritorious achievement in the development of electrical apparatus or machinery."

Mr. Lamme made similar bequests to the *Society for the Promotion of Engineering Education* and Ohio State University, providing in the former for the annual award of a medal for accomplishment in technical teaching or actual advancement of the art of technical training, and in the latter for the annual award of a medal to a graduate of the University in any branch of engineering for meritorious achievement in engineering or the technical arts.

Engineers' Council for Professional Development

Thirty-four colleges and universities in the New England and Middle Atlantic States have responded to the program of inspection and accrediting of engineering curricula, which the Engineers' Council for Professional Development offered to schools granting engineering degrees. Work was begun in these two sections late last year and is to be actively continued during the next few months, and it is anticipated that the program will be extended to include engineering schools throughout the United States.

The accrediting program has for its purpose the development of engineering education by identifying those institutions which offer engineering curricula worthy of recognition as such. Another objective is to establish a list of accredited engineering schools, which it is hoped may be uniformly adopted by educational, technical, and state organizations.

Headquarters of the Engineers' Council for Professional Development are at 29 West 39th St., New York, N. Y.

Brooklyn Polytechnic Institute Establishes Graduate Faculty and Extends Courses

The establishment of a graduate faculty and the inauguration of courses leading to the degree of doctor of philosophy in chemical and electrical engineering have been approved by the corporation of the Polytechnic Institute of Brooklyn, N. Y., and will be effected in the immediate future, according to the announcement of Pres. Harry S. Rogers.

With the addition of the doctorate in two more fields, Polytechnic will be enabled to increase its educational service, offering engineering study of graduate standing at hours suitable to engineers concurrently engaged in their professional work.

The college has provided equipment and facilities for research leading to the doctoral dissertation in a variety of subjects. In the department of chemical engineering, these include such fundamental unit operations as evaporation, distillation and heat transfer, the unit processes of organic synthesis, as well as paint and varnish research. In electrical engineering, the college offers facilities for advanced research in studies of dielectric properties, transients on lines and in machines, high frequency phenomena, and metallic conduction of electricity.

Proceedings of the 42nd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Chicago, Illinois—January 27-30, 1936

THE 42nd Annual Meeting of the Society held at the Palmer House, Chicago, Ill., January 27-30, established a record for attendance with a total registration of 1,266 members, guests and ladies from all parts of the United States and Canada. Representatives from each of the Society's twenty local chapters were present to participate in the discussions and to attend a meeting of the chapter officers.

Unusually large audiences were present at all of the regular business and technical sessions to discuss the Research Committee Report, the proposed Code for Rating and Testing Air Conditioning Equipment, and the papers presented on a variety of technical subjects. A delightful innovation that was greatly enjoyed was the joint session of the *National Warm Air Heating and Air Conditioning Association* and the Society on January 29.

On January 27 the Council attended a luncheon and meeting at the Saddle and Sirloin Club, Stock Yards Inn, with every member in attendance and then took part in the formal opening of the 4th International Heating and Ventilating Exposition held at the International Amphitheatre. During the five days in which the Exposition was open for inspection, nearly 50,000 people viewed the equipment of over 310 various manufacturers.

FIRST SESSION—

Monday, January 27, 1936, 10:00 A. M.

President John Howatt, Chicago, called the 42nd Annual Meeting of the Society to order in the Red Lacquer Room of the Palmer House and outlined briefly the various important events of the meeting. President Howatt then read his report.

Report of the President

A survey of the activities and affairs of the AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS for the past year justifies the optimism that is felt by your officers in looking toward the future. The reports from the different committees of the Society will present a picture of progress and solidification in the year through which we have come that should make all have faith in the foundations and structures that have been built.

The most important asset of this Society is its membership and while the membership is not large when compared with some national organizations, because of the character and interest of the members, it has an effectiveness far beyond that which is accounted for by numbers only. The membership list has been revised until today those whose names appear on it have a real interest in our success.

Our finances are on a sound basis with our assets, so liquid, any emergency can be met. Expenses have been maintained substantially below revenues in order that we may again commence to build our endowment accounts and provide for future security.

The TRANSACTIONS for the years 1933 and 1934 are being printed and within a month will be in the hands of the members. The publication of these TRANSACTIONS is an obligation the Society owes to its members and it is my hope that never again will the publication of these valuable records be delayed as was the publication of the 1933 TRANSACTIONS.

THE GUIDE continues to be of more and more importance in the affairs of the Society. It has become the encyclopedia of technical information for the heating, ventilating and air conditioning engineer and the recognized authority in its field. It is bringing a great deal of favorable attention and comment to the Society as a whole. In addition it has proven to be a source of revenue almost every year, with the sales for the past year exceeding that of any other. The success of THE GUIDE is very largely due to the capable energetic work of our Secretary, A. V. Hutchinson, the work of John James, and the work of the members of the Society who were selected to form the Guide Publication Committee and those who so generously helped this committee in the preparation of text material.

The publication of our papers in the JOURNAL SECTION of Heating, Piping and Air Conditioning has continued to demonstrate the wisdom of those who arranged for the original contracts. Dealings with the publishers have been uniformly agreeable and satisfactory since their beginning.

As conditions in the business field continue to improve and our revenues from our publications and other sources increase, the president believes we should, as soon as possible, make arrangements to reduce the dues of members to $15.00 per year. The budget of the Society could even now be prepared on that basis, so I recommend consideration be given to this change in our dues account at an early date. The importance of the work in Chapters is recognized and should be supported and promoted as far as possible. A reduction in the cost of belonging to the Society will make it easier for Chapter groups to obtain working funds from their members.

Our Research program has been maintained as actively as finances permitted. Research is one of the activities that has made this Society outstanding among engineering organizations and should be maintained as extensively as possible. Your President believes a definite policy providing that a certain proportion of the net profits from THE GUIDE be set aside for Research should be established. There should be an extension of co-operative Research agreements with other institutions and a definite policy of conducting fundamental rather than specific Research. Research in the relationship between air environment, physiology, pathology; on the relationship between the environment and human health and well being.

I cannot close this message without expressing my gratitude to the members in conferring upon me the honor of being their Chief Administrative Officer for the past year. Whatever success may have come from my efforts to increase the prestige and influence of the Society, to stimulate the interest in Chapters and bring about a feeling of friendship and cohesion among our geographically wide-spread units has been possible only through the friendly co-operation and support it has been my good fortune to receive. The real work is done by your Council and the regular and Special Committees appointed. It augurs well for the future that we are able to draft members who give freely of their time and talent in the interest of our Society.

JOHN HOWATT, *President.*

The report of the President was recorded and approved as read.

The report of the Treasurer was then introduced and was personally presented by the Treasurer, A. J. Offner, New York.

Report of the Treasurer

Your Treasurer is very happy to report that the treasury is in very good condition. As of December 31, 1935 there was a balance in all funds of over $51,000 and the market value of securities we have amounts to about $20,000, making a total of over $71,000. Rather than quoting a lot of detail figures which you probably would not be interested in and probably would forget as soon as you heard, I would refer those members who are interested in that to the Report of the Finance Committee and the certified public accountant.

A. J. OFFNER, *Treasurer.*

President Howatt ruled that if there was no objection the Treasurer's Report would be made a part of the records and approved as read.

A. V. Hutchinson then read the Report of the Secretary.

Report of the Secretary

In this brief description of the work of the headquarters office it will show that the Society's activities increased tremendously during 1935. A substantial increase in membership was recorded, a larger GUIDE and a greater volume of sales, production of two volumes of TRANSACTIONS, together with normal routine of issuing the monthly JOURNAL, handling memberships, accounts, changes of addresses, codes and other administrative matters has required the careful attention of the office personnel to handle the innumerable details and meet the demands for service. The production of THE GUIDE required a full nine months, the Committee establishing the outline, the reviewing, revising, and editing, before printing, proof reading, binding and distribution. The increased demand for this reference volume had exhausted the entire 1935 edition by November 1 and the Guide Publication Committee will report that the greatest sale of copies ever recorded came during the past year.

An enlarged headquarters office was leased this year and if Society activities continue at the present pace, these quarters will be cramped within another year.

The tremendous public interest in automatic heating, and air conditioning has brought a heavy volume of inquiries to the Society's headquarters which has acted as a clearing house in advising of information sources and service.

The work of the Society to obtain employment for members has been actively continued throughout the year with the result that many leads have been given to those who needed employment.

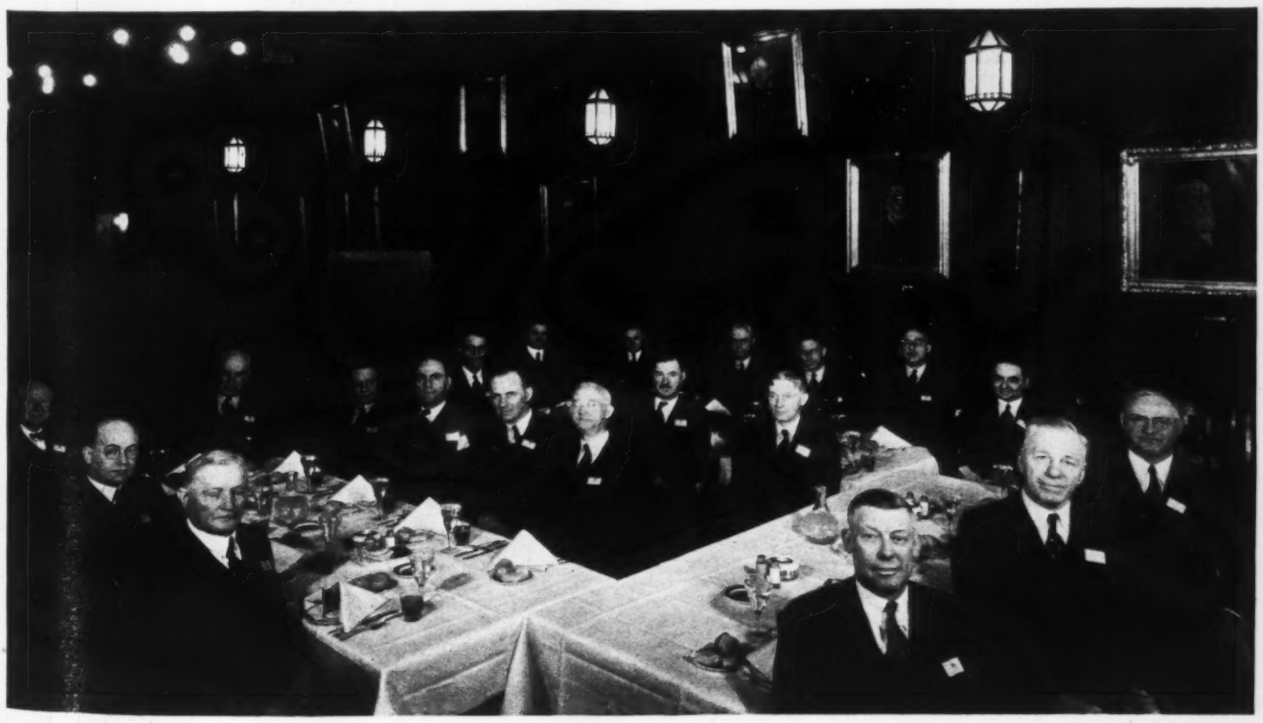
Proposed changes in the Society's Constitution and By-Laws were voted on by members and new rules for Student Member qualifications have been adopted. The result of the voting will be announced by the tellers at this session.

The Roll of Membership compiled for THE GUIDE 1936 records more than the usual number of changes and members are urged to co-operate in keeping the headquarters office informed of changes in location or mailing addresses so that Society mail and publications may reach them promptly.

A net gain in the Society's membership has been recorded and a comparison of the status as of December 31, 1934 and December 31, 1935 is of interest:

	1935	1934
Honorary Membership	1	2
Presidential Members	24	23
Members	1248	1156
Associate Members	407	339
Junior Members	216	233
Student Members	148	97
	2044	1850

Co-operation with Chapters has been stimulated this year



A. S. H. V. E. Council at Luncheon in the Saddle and Sirloin Club

and in many cases subjects and speakers have been arranged for by the Society.

Special attention has been given to the newly organized chapters in Washington, D. C., Oklahoma City and Winnipeg, and there is prospect for additional chapters in several other cities where local members feel that interest has reached the point where a Society organization can function effectively.

In accordance with custom, the headquarters staff in co-operation with the Program Committee and the Local Chapter Committees worked out details of the Annual and Semi-Annual Meetings.

It is with genuine pleasure that we acknowledge the co-operation given by the Officers, Council members, Chapter Officers and Committees, as well as the Research Laboratory who have made 1935 a successful year for the Society.

Acknowledgment should also be made for the assistance of the headquarters office for their interest, loyalty and faithful performance of manifold duties required to successfully handle the administration activities of the Society.

Respectfully submitted,

A. V. HUTCHINSON, *Secretary.*

Mr. Howatt ruled that if there were no comments or objections the report would be published as read.

The Secretary then presented the Report of the Council.

Report of Council

Since the last Annual Meeting, three meetings of the Council have been held to carry on the business of the Society and the membership will be glad to know that definite progress was made towards strengthening the Society's membership and its financial condition.

At the organization meeting of the Council held in Buffalo, President Howatt announced committee appointments in accordance with the provisions of the Constitution and By-Laws, the appointment of A. V. Hutchinson, Secretary, was confirmed, depositories for Society Funds were selected and the Budget for 1935 approved by the Finance Commmittee was adopted. The Budget estimate indicated total income of $59,633.24 and an estimated expenditure of $58,650.00. The report of the Finance Committee will indicate that a greater revenue was produced and expenditures were proportionately maintained.

The Council appointed the F. Paul Anderson Award Committee in 1935 and the unanimous choice of the Committee reported to the Council and approved was that Dr. Arthur Cutts Willard, Urbana, Ill., president of the University of Illinois receive the F. Paul Anderson Medal for 1935. The presentation was to be made by President Howatt at the 42nd Annual Banquet, January 29, 1936.

One of the most important actions of the Council was the co-operative movement started by the Council to encourage greater interest in Society activities and the means was provided for an official delegate from each Chapter to be present at this meeting.

Another significant action was the authorization of an exchange service plan to members in co-operation with the *A. S. R. E.* for the year 1936 and, since the announcement was sent out in December, 200 members have indicated their desire to participate in this plan.

To extend the scope of the Society's technical activities, John W. James joined headquarters office staff in April.

At the June Meeting of the Society, a detailed report was given on the progress of the Fourth International Heating and Ventilating Exposition and the Society is indebted to the members of the Advisory Exposition Committee for the splendid cooperation that they rendered to the management of the Exposition, in order to produce the great spectacle which opens today at the International Amphitheatre.

As required by the Society's Constitution and By-Laws the Council established the dues rate for the year 1936 and announced nominations for five members of the Committee on Research to serve for a three-year period commencing in 1936.

The invitation of the Philadelphia Chapter to hold the Semi-Annual Meeting 1936 at Buck Hill Falls, Pa., was approved by the Council and announcement has been made that this will be a joint meeting with the *A. S. R. E.* on June 22 to 24.

Due to improved financial conditions some progress was made in changing Society investments in accordance with recommendations from the Finance Committee, so that practically all surplus funds of the Society are now in U. S. Government securities as required by the By-Laws.

During 1935 three new chapters were successfully launched; the Council granting Charters for local chapters to members in Washington, D. C., Oklahoma City and Winnipeg.

As required by the Constitution and By-Laws the Council confirmed the election of members in accordance with recommendations of the Committee on Admission and Advancement. For the twelve months of 1935, 358 applications were received. It was also necessary for the Council to act on the resignations of 45 members during the year and to cancel 73 memberships in accordance with the By-Laws.

The Council regrets the death of its first President, Stewart A. Jellett and several of its oldest members who joined the Society over 25 years ago, C. W. Christian, R. Collamore, G. M. Getschow and J. D. Small.

The Society has passed through a year of substantial growth and prosperity and the Council wishes to acknowledge the interest and cooperation of the various Committees and individual members who have contributed to its progress in 1935.

Respectfully submitted,

THE COUNCIL.

There being no changes or modifications to the report, President Howatt said that it be published as read.

Report of the Finance Committee was introduced by E. H. Gurney, Toronto.

Report of the Finance Committee

The accounts of the Society for the year 1935 reflect not only the general improvement in business conditions, but also the great increase and the particular interest in the field of engineering covered by the Society.

Your Society shows a surplus for its year's activities of approximately $10,000, which is, however, reduced by two special appropriations: one of $600 for editorial services, and the other of $1,500 for the Research Fund. It is recommended that this surplus be used for the purpose of restoring the Endowment Fund to a figure close to its original proportions.

After a year of delightful cooperation with your President, I find that I am not quite at one with him in respect to this matter of fees. True, we had this surplus last year. It is however equally true that the budget, which will be presented by this Committee to your incoming Council, will show no surplus. The growing field of activity to be covered by the Society, plus the fact that last year everybody in the Society's employ had to work at almost too high tension, means that, if we do our duty, we cannot be sure of looking forward to any surplus and immediate reduction in dues and, therefore, in my opinion we must not jump to the conclusion that dues must be reduced immediately.

The improvement in revenue for the Society comes largely from two sources. One, the collection of dues from membership which is up from $15,870 in 1934 to $19,438 in 1935. The other source is from the publications. Here, there is another factor which has worked for improvement in addition to the conditions referred to above: namely, in the improvement in THE GUIDE itself. This revenue is up from $32,371 in 1934 to $47,309 in 1935.

In expenditures there are no important modifications that

should be commented on, other than that occasioned by the increased volume of the publication output.

Your Committee has seen fit to modify the endowment investments of the Society by meeting the new By-Law requirement for government securities in liquidating certain bonds and reinvesting. We now have left only one non-trustee security, which your Committee recommends that the incoming Finance Committee shall also convert to government bonds.

There is only one phase of the financial picture which still shows a discouraging result: namely, the contributions from private individuals or companies to Research, either earmarked for a specific purpose or for general research. Virtually, something over 90% of all contributions received for this purpose last year came from one organization and for a particular project. Having regard to our past record along these lines, it would appear that many organizations affiliated with the A. S. H. V. E. do not realize or appreciate the value of the service which might be rendered them through the Research Laboratory and cooperating institutions.

Your Committee desires to summarize the balance sheet and income and expense statement from the certified copy of the accounts audited by Price, Waterhouse and Co., which will be filed as a matter of record with the Secretary of the Society.

There have been numerous modifications in the Society's office methods in the last year inherent to a rapidly growing business and the writer would like to record his appreciation of the way the staff has taken the extra thrust, including very heavy demands on their time.

All of which is respectfully submitted,

The Finance Committee,

E. H. Gurney, *Chairman.*

Mr. Gurney then moved the adoption of the report and it was regularly seconded and carried and made a matter of record.

BALANCE SHEET*

American Society of Heating and Ventilating Engineers

December 31, 1935

ASSETS

GENERAL FUND ASSETS:		
Cash in banks and on hand	$ 38,441.46	
Cash deposit in closed bank	500.00	
Interest accrued on investments	61.42	
Investments in marketable bonds at cost (Market value at December 31, 1935 approximates $11,600.00)	11,525.31	
Members' dues receivable $17,936.37		
Deduct—Reserve thereagainst 13,500.00	4,436.37	
Owing by advertisers and sundry debtors $28,017.53		
Deduct—Reserve thereagainst 2,500.00	25,517.53	
Inventories of publications and emblems, at cost or lower	2,750.39	
Furniture and fixtures $ 5,433.95		
Deduct—Reserve for depreciation 4,314.42	1,119.53	
Library, at nominal value	300.00	
Prepaid expenses	518.99	
		$ 85,171.00
ENDOWMENT FUND ASSETS:		
Cash in bank	$ 5,248.14	
Interest accrued on investments	143.00	
Investments in marketable bonds, at cost (Market value at December 31, 1935 approximates $8,400.00)	11,918.65	17,309.79
THE F. PAUL ANDERSON MEDAL FUND ASSETS:		
Cash in bank	$ 1,086.40	
Cash deposit in closed bank	33.22	
		1,119.62
RESEARCH FUNDS ASSETS:		
Endowment Fund Assets:		
Cash in bank	$ 443.06	
Cash deposit in closed bank	213.53	
		656.59
Unrestricted Fund Assets:		
Cash in bank and on hand	$ 5,815.10	
Owing from General Fund on dues collected, etc.	2,363.52	
		8,178.62
		$112,435.62

LIABILITIES

GENERAL FUND:		
Accounts payable	$ 6,817.83	
Prepaid dues	1,624.06	
Owing to Research Fund:		
On dues collected $ 2,363.52		
On dues when collected 1,972.52	4,336.04	
Prior years' dues of reinstated members, to be collected	307.00	
Reserves' for publications	22,400.00	
Fund balances:		
At January 1, 1935 $41,490.53		
Add—Excess of income over expenses and appropriations for the year ending December 31, 1935	8,195.54	49,686.07
		$ 85,171.00
ENDOWMENT FUND:		
Fund balance at January 1, 1935—		
Principal $16,686.13		
Deduct—Loss on sale of investments	322.85	$16,363.28
Unexpended income $ 980.84		
Add—Interest on investments 628.17		
$ 1,609.01		
Deduct—Appropriation to Research Fund	662.50	946.51
		17,309.79
THE F. PAUL ANDERSON MEDAL FUND:		
Fund balance at January 1, 1935:		
Principal	$ 1,000.00	
Unexpended income $ 96.01		
Add—Interest on bank deposit 23.61	119.62	
		1,119.62
RESEARCH FUNDS:		
Endowment Fund:		
Principal	$ 600.00	
Unexpended income, January 1, 1935 $ 46.94		
Add—Interest on bank deposit 9.65	56.59	
		656.59
Unrestricted Fund:		
Balance, January 1, 1935	$ 7,484.18	
Excess of income over expenses for the year ending December 31, 1935	694.44	
		8,178.62
		$112,435.62

*Accompanying report of Price, Waterhouse & Co., dated January 21, 1936.

Statement of Income and Expenses and Appropriations Year Ending December 31, 1935

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

GENERAL FUND

Income:		
Current year dues		$30,649.92
Deductions as provided in By-laws:		
Members' subscriptions to JOURNAL	$ 4,146.72	
Contributions to Research Fund—40% of dues of Members and Associate Members only	11,145.28	15,292.00
		$15,357.92
Prior years' dues collected from reinstated members		144.00
Editorial services		12,800.04
Interest on investments and bank deposits	$ 985.94	
Less—Loss on sale of investments	931.69	54.25
Office furniture—Profit on sale		71.50
Publications:		
Sales (net) of GUIDE—1935 edition	$21,941.72	
GUIDE advertisements—1936 edition	25,367.93	
Sales of TRANSACTIONS	156.20	
Sales of reprints, books and pamphlets	250.39	47,716.24
Miscellaneous income		99.37
Total income		$76,243.32
Expenses:		
Publications:		
GUIDE 1936 edition—Printing, binding and distribution, including provision of $12,500.00 therefor	$26,758.59	
GUIDE 1935 edition—Distribution, etc.	4,667.54	
TRANSACTIONS 1933 and 1934 editions—additional provision for publication	966.02	
TRANSACTIONS 1935 edition—Provisions for publication	3,000.00	
YEAR BOOK—Printing, etc. including provision of $700.00 therefor	1,021.61	
Codes—Printing, etc.	57.28	$36,471.04
Salaries	$13,194.00	
Rent and light	2,583.37	
Postage	1,941.92	
Meetings	824.60	
Chapter meeting allowance	1,000.00	
President's Fund	1,063.39	
Traveling—Secretary	951.89	
General printing	400.00	
Multigraphing	374.67	
Telephone and telegraph	791.31	
Office supplies	417.43	
General office expense	555.01	
Awards	240.21	
Discounts	353.31	
Professional fees	500.00	
Depreciation of furniture and fixtures	534.97	
Provision for doubtful accounts	3,490.55	
Miscellaneous	250.11	29,476.74
Total expenses		$65,947.78
Excess of income over expenses		$10,295.54
Special appropriations authorized by Council:		
For editorial services	$ 600.00	
For Research Fund	1,500.00	2,100.00
Excess for year of income over expenses and appropriations—General Fund		$ 8,195.54

The Membership Committee Report was presented by F. C. McIntosh, Pittsburgh, Pa.

Report of Membership Committee

Probably due to the change in the times, the work of this Committee has been unusually easy and agreeable during the past year. Following the idea of President Howatt, and the general thought that a Society like ours should not expand too rapidly, we have conducted no membership campaign. We have, however, developed and maintained a card file of men who might be eligible. This now consists of over 1700 names. When we learned from any source that a man was in the field of heating or air conditioning, a card was prepared for him and put in the file, where it remained until an application was received, or until we had definite reason to believe he was not interested.

Each of these men has received at least one letter from us. In most cases, the first letter was one briefly mentioning the Society and its purpose, with a request for reply as to whether or not the recipient was interested in receiving further information. If the answer was affirmative, a second letter was sent out with full details of the advantages and obligations of membership. If this letter was not answered, a follow-up was sent to ask if any more information was desired. As an indication of the value of this system, we report that about 40 per cent of the members elected during the year had been listed.

Fifty per cent of those who were sent our initial letter, replied—a very good response. Of these replies, three per cent indicated definite lack of interest, and their cards were removed. Some reported an intention to apply for membership later, but an inability to do so at the time, for financial or other reasons. The file card was marked accordingly.

Members elected to the various grades during the calendar year 1935 are as follows:

Members	127
Associates	79
Juniors	55
Students	91
Total	352

By the twentieth of this month, the Council was voting on approximately forty more.

Although the general growth for the year was healthy, the outstanding membership event was the receipt of applications for four new Chapter Charters. Three of these have been granted; one for Manitoba, Canada, one for Oklahoma City, Okla., and one for Washington, D. C., and the fourth, from Baltimore, is under consideration. There is a great deal of work to be done by a local group in forming a chapter and it is often largely assumed by a few men. The Society is particularly indebted to Colonel W. A. Danielson for the large District of Columbia Chapter; to Professor E. F. Dawson, and to F. X. Loeffler for the Oklahoma group, to C. H. Turland for the second Canadian Chapter, and to J. E. Seiter for the proposed application from Baltimore.

It is our belief that our Society's healthy growth in size and in influence, is best promoted by formation of additional chapters, and we hope that in the near future, this action, can be taken in such districts as Atlanta, Dallas, Denver, Indianapolis, Montreal, New Orleans, Omaha and San Francisco.

In considering growth, this committee has always tried to keep in mind the fact that mere increase in numbers leaves much to be desired. Every man elected who is more valuable to us than our present average member, raises the standing by a certain amount, and just as truly, every man elected who is below this average, lowers it. It is quite possible that the best result would be obtained by limiting our membership to a certain maximum number, for a determined period. Such action would discourage the promiscuous solicitation of members and encourage the selection of the best men.

From the viewpoint of our membership work, we respectfully submit the following recommendations to our successors and to the Society as a whole: We recommend:

1. That additional chapters be formed just as rapidly as possible, wherever and whenever the membership is sufficient.

2. That the National Organization take a greater interest in the Chapters, especially the younger ones, and that this interest be expressed through a special committee, similar to the former Chapter Relations Committee. The re-establishment of the

meeting of the Chapter Representatives, and the efforts made to promote the attendance of Chapter Officers at this Annual Meeting are steps in the right direction, but something more should be done.

3. That the Chapters, in their regular sessions and their committee meetings, give more consideration to the affairs of the National Organization. One result might be the better preparation of the Nominating Committee members.

4. That for the reasons mentioned in the body of this report, a limit be placed on the number of Student Members and another limit on the total of other members elected, regardless of grade, and that the time and figures for these limits be set by the Council.

The reader takes this occasion to remark parenthetically, and gratefully, that this has been by no means a one man committee.

Membership Committee,
JOHN CASSELL,
W. A. RUSSELL,
F. C. MCINTOSH, *Chairman.*

President Howatt then briefly commented on the Report of the Membership Committee and indicated that certain of the recommendations outlined were worthy of careful consideration and would be referred to the Council for further action.

The next committee report was presented by the chairman of the Meetings Committee, Albert Buenger, St. Paul, Minn.

Report of the Meetings Committee

The functions of the Meetings Committee during the past year have been carried out as provided for in the By-Laws and resulted in the presentation of the papers at the Summer Meeting at Toronto in 1935 and at the 42nd Annual Meeting here in Chicago this week, which papers are a matter of record.

After a slow start the Committee finally got under way and with the invaluable help of Mr. Hutchinson the program for the Toronto Meeting was assembled.

After the Summer Meeting, papers began to come in and the notice sent out by the Secretary seemed to stimulate the production of papers. By the early fall it was evident that sufficient papers would be available for the Annual Meeting.

At the suggestion of President Howatt one of the papers from the Research Laboratory was circulated among the Chapters for presentation and discussion. From the reports we have received and from the experience in our own Chapters, it was evident that this arrangement proved to be very popular as well as profitable. We would seriously recommend that this arrangement be continued in the future.

One of the problems which presented itself during the year concerned the production of research papers. We should like to quote from a letter received from the Chairman of the Research Committee:

"I agree with you that the idea of having a research paper ready in time for discussion by the Chapters in the Fall is a good one. The only trouble with this is that the men doing the research are continuously being pushed to get out papers ready for the meetings. The result is that they are forced to work right up to the deadline in order to get in under the wire. This pressure I am afraid is sometimes going to lead to the presentation of half-baked results."

At the end of the year some papers have accumulated which can be presented at future meetings. We would therefore recommend that a policy be established to have at all times enough papers on reserve to prevent the crowding of the Research Laboratory staff and the last minute scramble for papers.

In closing we want to express our appreciation for the material assistance of A. V. Hutchinson and the staff at the New York office rendered in carrying out the work of the Committee.

Respectfully submitted,
Meetings Committee,
F. E. GIESECKE.
O. W. OTT.
ALBERT BUENGER, *Chairman.*

President Howatt declared that this Committee report should be included in the Proceedings of the meeting.

Prof. A. P. Kratz, Urbana, Ill., chairman of the Committee on Research, was then introduced and abstracted the Report of the Committee on Research with a few brief comments to amplify the important projects. (Complete Report of the Committee on Research appears in the February, 1936, Journal Section, *Heating, Piping & Air Conditioning*).

The report of the Guide Publication Committee was then presented by the chairman, Prof. G. L. Larson, Madison, Wis.

Report of Guide Publication Committee

The Guide Publication Committee has incorporated in the 14th edition of THE GUIDE many new and important additions to the Technical Data Section which extends its usefulness to all who are interested in the professional art of heating, ventilating, and air conditioning.

The original conception of the founders of THE GUIDE has been carefully protected in this new volume so as to maintain its continued role as an authoritative and unbiased presentation of long established as well as newly recognized scientific standards of the profession and allied industries.

Because of increasing demands from various users of THE GUIDE, and because of increased application of air conditioning and cooling to all types of industrial processing and comfort installation, four new chapters have been added to the Technical Data Section on the subjects of Refrigeration, Drying, Electric Motive Power, and Railway Air Conditioning.

In addition to this new material, all of the previous chapters have been carefully checked and reviewed, and in some cases the text has been completely rewritten. Information on unit heaters, ventilators, coolers, and air conditioners has been correlated in one chapter and completely revised. New tables of saturated water vapor, monthly degree day values, and a list of maximum city water main temperatures for over 250 representative cities in the United States and Canada are included.

Other chapters which have been amplified with much new material are: Cooling Methods, Fans, Industrial Exhaust Systems, Automatic Fuel Burning Equipment, Radiators and Gravity Convectors, Piping, Fittings, Welding, Water Supply Piping, Water Heating, Electrical Heating, and Air Conditioning for Industrial Processes.

Basic and fundamental data which have been added to THE GUIDE each year since its inception in 1922 have been retained with additions from research sources made necessary by the progress of the heating and ventilating art.

The Problems in Practice which were a major innovation of the last edition of THE GUIDE have been retained with new and practical examples to expand and amplify the text matter of each chapter. Over sixty new illustrations, curves and charts have been added which enhance the value of the descriptive text material.

In connection with the Manufacturer's Catalog Data Section, the Committee has made a more determined effort to carry out the original conception of having the descriptive material as free as possible from comparative statements and superlative

terms, and to present therein such condensed technical information concerning modern equipment as will be of practical value to the user of THE GUIDE.

In general, the manufacturers have cooperated fully to make their data useful, informative and serviceable, so that the user can apply it effectively in the selection of materials or equipment to be used in general design.

The Committee appreciates the aid of those far-seeing manufacturers who have assisted in this cooperative enterprise to advance the art of heating, ventilating, and air conditioning which so vitally affects the comfort, happiness and health of everyone. In 1936 it will be possible to distribute THE GUIDE to more than 12,000 users; and it is extremely gratifying that a greater number of manufacturers recognize the effective service rendered by this reference volume, and have increased their advertising space in order to carry the story of their products in greater detail to the thousands who use this book.

In summary, THE GUIDE 1936, compares with the previous edition as follows: the Technical Data Section has been increased 86 pages; Catalog Data, 40 pages,; Roll of Membership, 6 pages; and Frontispiece and Preface, 2 pages; making a total increase of 134 pages. The net sales of THE GUIDE 1935 was $21,941.72 and the income from 1936 GUIDE advertising contracts was $25,367.93.

In behalf of the members of the Society and the profession at large, the Guide Publication Committee gratefully acknowledges the cooperative efforts of the following individuals who have given so generously of their time to the development of this 1936 edition:

T. N. Adlam	H. F. Hutzel	C. Z. Rosecrans
J. J. Aeberly	C. F. Kayan	J. O. Ross
O. W. Armspach	R. T. Kern	S. I. Rottmayer
C. L. Arnold	R. E. Keyes	Prof. F. B. Rowley
C. M. Ashley	Prof. V. O. Knudsen	S. S. Sanford
W. R. Beattie	J. W. Kreuttner	Prof. W. M. Sawdon
E. H. Beling	C. H. Lankford	Prof. L. E. Seeley
J. L. Blackshaw	L. L. Lewis	C. G. Segeler
M. G. Bluth	Prof. Axel Marin	H. C. Sharp
C. A. Booth	T. A. Marsh	J. D. Smith
Albert Buenger	H. C. Murphy	A. E. Stacey, Jr.
W. H. Carlton	Prof. D. W. Nelson	B. Steele
Sabin Crocker	P. Nicholls	D. J. Stewart
D. N. Crosthwait, Jr.	R. F. Norris	C. A. Thinn
J. M. DallaValle	A. J. Offner	W. D. Turnbull
John Everetts, Jr.	O. W. Ott	G. H. Tuttle
J. W. Hertzler	J. S. Parkinson	J. H. Van Alsburg
E. L. Hogan	G. C. Polk	H. A. Wagner
J. H. Holton	E. C. Rack	A. R. Walker
F. C. Houghten	H. G. Rappolt	W. K. Walker
Prof. C. M. Humphreys	Prof. T. F. Rockwell	Prof. C. P. Yaglou

The cooperation of A. V. Hutchinson, Secretary, and John James at the headquarters office who assisted in the preparation of THE GUIDE was of invaluable help to the Committee.

The Committee has released this 14th edition of over 12,000 copies with the sincere hope that it will receive the same generous reception that was accorded its predecessors, and that users will find it the most valuable reference volume in their library.

Guide Publication Committee,

G. L. LARSON, *Chairman.*

Report of Committee on Proposed Standard Method of Rating and Testing Air Conditioning Equipment

President Howatt introduced W. E. Stark, Cleveland, O., Council member and chairman of the committee who represented the Society in the preparation of the proposed Standard Code for Rating and Testing Air Conditioning Equipment, sponsored by *A. S. R. E.*

Mr. Stark presented a brief abstract of the code.

This Code which is now being reported on is already well known to those members of this Society who are also members of the *American Society of Refrigerating Engineers* or to those who are members of some of the other sponsoring organizations; but to those who are members of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS only, it may need an introduction. A brief outline of its history will be given.

At the 1930 Spring Meeting of the *A. S. R. E.*, a discussion of condensing unit ratings led to a Committee being appointed to consider a modification of the Standard Ton of Refrigeration as applied to mechanical condensing units. This committee grew in 1931 into a joint committee, composed of representatives of *A. S. R. E.*, *R. M. A.*, and *N. E. M. A.* This joint committee met during each *A. S. R. E.* meeting in 1932 and 1933.

At the suggestion of the *R. M. A.*, in 1934 the scope of the joint committee was extended to include the rating and testing of air conditioning equipment. At the December, 1934 meeting of the *A. S. R. E.* Council, this Committee presented a report on a Standard Method of Rating Mechanical Condensing Units which was approved for a period of a year by that Council and also approved by *R. M. A.* and *N. E. M. A.*

In January, 1935 the *A. C. M. A.* was invited by the sponsoring society, *A. S. R. E.*, to appoint three representatives to the Committee and a short time later our Society was invited to participate. We were first represented at a meeting in July, 1935 by John James and then at a meeting in September, 1935 by a Committee composed of F. H. Faust, C. W. Walton, Jr., and W. E. Stark. In September, 1935, the two codes produced by the Committee, relating respectively to mechanical condensing units and to air conditioning units were approved by the *A. S. R. E.* Council and later by the *R. M. A.* and *A. C. M. A.* In December they were approved by the *A. S. R. E.* at its Annual Meeting and also by our own Council.

As the Code on condensing units stands at present, units are rated in four groups, or have four ratings, each at a different evaporator temperature; one of which is appropriate to air conditioning work.

Crank case and condensing water temperatures are also standardized. According to the Code the performance of a unit involves the determination of:

1. Refrigerating capacity in Btu per hour.
2. Power consumption in watts.
3. Water consumption in gallons per hour.

The Code describes in great detail several recognized methods of testing condensing units, which are classified as primary tests and confirming tests. Primary test methods are those in which the refrigerating effect is measured directly, while confirming test methods are those which depend upon the properties of the refrigerant and require very exact knowledge of its thermodynamic characteristics. The allowable deviation between primary and confirming tests is so small as to invalidate any confirming test in which there is much uncertainty about the properties of the refrigerant.

The Code on Rating and Testing Air Conditioning Equipment is the one that is of direct interest to Heating and Ventilating Engineers, and is the one that we are concerned with. By definition its scope is to *prescribe the methods of rating and testing air conditioning and air treating units of the forced convection type.* Seven bases of rating are set forth, as follows:

(a) Comfort cooling with volatile refrigerant.
(b) Comfort cooling with non-volatile refrigerant.
(c) Commercial cooling with volatile refrigerant.

(d) Commercial cooling with non-volatile refrigerant.
(e) Heating with steam.
(f) Heating with liquid.
(g) Humidifying.

Items which shall be included in the rating are prescribed and test methods are described in detail. There are two permissible test methods; one employing a receiving chamber with impact nozzle, which is according to the principle incorporated in the A. S. H. V. E. unit heater testing code; and the other employing a receiving chamber with static nozzle. Anemometer tests are not recognized.

The concluding part of this Code is a set of definitions pertaining to such things as appliance designations, system designations and definitions of various air conditioning effects. They will be found to be in agreement with the definitions recognized by this Society.

This Code does not set up any new air conditioning standards, such as standards of design and performance of air conditioning systems. It merely sets forth certain things that are to be included in the ratings of air conditioning units and prescribes how those things are to be determined. They are of interest to the Heating and Ventilating Engineer in that they prescribe certain standard ways of determining and expressing the quantitative data that he needs if he is to make an intelligent selection of equipment. They insure that every equipment manufacturer's performance facts are learned by the same methods and expressed in the same language.

This Society did not directly have a great deal to do with the preparation of this Code. The work was practically completed before we had any representation on the Joint Committee. However, we were in effect represented practically from the beginning, in that several of the representatives of other organizations are active members of our own Society. The code represents the combined efforts of the leaders in the industries which manufacture the articles that we specify and purchase, and merits a trial on our part. The time is not yet ripe to make it one of our standards, for we need to see it used and to observe its effects.

A lengthy discussion then followed which was participated in by C. V. Haynes, Philadelphia, Pa., Prof. G. L. Tuve, Cleveland, O., and S. R. Lewis, Chicago, Ill. Prof. W. M. Sawdon, Ithaca, N. Y., moved that the Society receive the report and approve the work done to date. The motion was regularly seconded and when presented to the members for a vote was unanimously carried.

W. T. Jones, Boston, Mass., presented the Report of the Tellers as follows:

Reports of Board of Tellers

The votes cast for Officers have been tabulated by your Board of Tellers with the following results:

President—G. L. Larson....488
First Vice-President—D. S. Boyden....488
Second Vice-President—E. H. Gurney....487
Treasurer—A. J. Offner....488

Members of the Council—Three-Year Term:

R. C. Bolsinger....488
S. H. Downs....485
W. J. Fleisher....488
C. M. Humphreys....488

Scattering votes were recorded for Messrs. H. H. Angus and J. M. Frank.

The votes cast for Members of the Committee on Research have been tabulated by the Board of Tellers with following results:

Three year term:
W. A. Danielson....488
C. E. Lewis....488
D. W. Nelson....488
C. Tasker....488
C.-E. A. Winslow....488
Total number of legal votes cast....488

Respectfully submitted,
R. H. Carpenter, *Chairman.*
R. W. Rodman.
W. Walter Timmis.

President Howatt then stated that in accordance with this report the candidates for various positions in this Society were declared elected to their respective positions and installation of officers would take place on January 30.

W. T. Jones read the result of the ballot on Constitutional Amendment which referred to a lowering of the age of Student Members to 18 years to satisfy the requirements of a few colleges. The votes cast for Amendments to the Constitution and By-Laws have been tabulated by the Board of Tellers and the following are reported:

Art. C-II Sec. 7....445 yes; 15 no
Art. C-III Sec 4....439 yes; 21 no
Total number of votes cast....500
Total legal votes....460

Respectfully submitted,
R. H. Carpenter, *Chairman.*
R. W. Rodman.
W. Walter Timmis.

According to Report of the Tellers President Howatt ruled that the Amendments to the Constitution and By-Laws were passed and would be effective with the regular constitutional procedure of adoption.

The first session adjourned at 11:55 a. m.

SECOND SESSION—

Tuesday, January 28, 1936, 9:30 A. M.

The second session of the Society's Annual Meeting was called to order by President Howatt who introduced J. H. Milliken, Chicago, president of the Illinois Chapter and general chairman of arrangements for the meeting.

Mr. Milliken extended greetings and spoke of arrangements for the various entertainment functions during the week.

President Howatt responded with the assurance that all of the educational and social needs of the members present had been adequately provided. He emphasized the fact that friendliness had been the keynote of the administration and assured the committee that the planned arrangements indicated that the spirit of friendliness would permeate the atmosphere of the entire meeting.

President Howatt indicated that funeral services for George V, King of England, were being held on that morning throughout the entire British Empire by proclamation of King Edward VIII. As a tribute and out of respect to the forty Canadian members present he suggested that the assembly rise and remain standing for one silent minute. All of the members then rose and stood in silent tribute to the late King George V of England.

The meeting was honored by the presence of Edward

J. Kelly, Mayor of the City of Chicago, who appeared before the meeting to extend welcome and greetings to the members of the Society. President Howatt in introducing the Mayor stated that Mr. Kelly himself had practiced the profession of engineering for many years and it was evident that many of his interests and sympathies were associated with such a group of men as assembled at the Society meeting.

Address of the Mayor

Mayor Kelly then responded with the following remarks:

Mr. Chairman, Members of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS:

I am glad to be here this morning because of the fact that I personally, and the people of Chicago, want to thank you for coming to this city. We feel you must consider this city to be centrally located and that it must be a place where you can discuss matters of your organization to such an extent as to bring about results. We are more than delighted that this grand Exposition is being held here, and we are sure that many people from all over the world will have access to it.

We again are proud because of the fact that you saw fit to elect as your President a man in whom I have the utmost respect and confidence, the man who heads our great School Board, as far as the engineering is concerned, and who, we feel, is second to none in the engineering field in this city or any other city. So we of Chicago are rather proud to know that he is the President of your Society. We know that he has given good service.

There is not much more I can say this morning except, as I said previously, we are glad to have you, and I am only here because I happen to be mayor of Chicago, representing the people of Chicago, and I speak their language. I am here to show you that we are glad, and do appreciate your presence. If there is anything we can do for you, we want to do it, and we want you to enjoy yourselves while you are with us.

While this weather isn't as pleasant as we would like it to be, we thought that as long as the Canadians were here we would give them something they might be accustomed to, and be satisfied with.

You are going to enjoy yourselves in Chicago, and it is a pretty good town, if I do say it myself, and I think you will find everything that a person could want in the way of business, recreation or anything you might see fit to do.

We have some wonderful stores, and I suppose it would be out of place if I were to ask you to tell your wives to get busy in the shops, for that does not line up with the expenses of the convention.

I hope to see your great Exposition, and I know the people of Chicago will appreciate it very much in these days when your profession is much in demand. When I say "much in demand," it is because you have made great strides, probably more than any other profession in the country, doing more towards making people comfortable, and doing more towards developing business in a general way.

I would like to congratulate this organization and its Officers because of the fact that they are working to help one another, and are aiming to develop their industry to such an extent that it will not lag behind other industries. And unless this is done, everything will die in this country or any other country, whereas the right kind of organization, built for the purpose of helping one another rather than for the purpose of tearing down, is always bound to succeed.

I want to say again that I hope I have the privilege of meeting you here in the future, that you will like this city so well you will come back, and I know the Entertainment Committee of this organization is going to see that you have a wonderful time. As I said before, the key is on the outside, and if the Mayor's Office can be of service, I know the Officers will call on us. Thank you.

President Howatt in responding to the Mayor's remarks stated that his appearance before the Society assured it of an auspicious beginning so that it would be possible for the members present to carry on with increased enthusiasm during the meetings to follow.

The first technical paper on the program entitled, Thermal Properties of Concrete Construction, by Prof. F. B. Rowley, A. B. Algren and Clifford Carlson, was presented by Professor Rowley, Minneapolis. (Complete paper published in January, 1936, Journal Section, *Heating, Piping and Air Conditioning*). Comments on this paper were offered by R. E. Copeland, Chicago, W. A. Danielson, Washington, D. C., and a written discussion by F. G. Hechler and E. R. Queer, State College, Pa., was read by John James. Professor Rowley responded to the various questions and in closing pointed out that the tests in this paper were the result of the fullest cooperation of the Research Laboratory, of the *Portland Cement Association* and the industry and only through that special cooperation was the investigation possible.

A paper entitled, Comparative Study of Combustion Results with Various Thermostats, was presented by Burton E. Shaw, Des Moines. (Complete paper published in March, 1936, Journal Section, *Heating, Piping and Air Conditioning*). Comments on this paper were offered by Prof. D. W. Nelson, Madison, W. A. Danielson and W. R. Beach, Cleveland, all of which were answered by the author, Mr. Shaw.

The paper, Fuel Saving Resulting from the Use of Storm Windows and Doors, by A. P. Kratz and S. Konzo, was given by Professor Kratz. (Complete paper published in December, 1935, Journal Section, *Heating, Piping and Air Conditioning*). Discussion which followed regarding this paper was conducted by Prof. F. B. Rowley, B. E. Shaw, W. A. Danielson, Prof. G. L. Larson and W. C. Randall, Detroit. A detailed reply to the questions was given by Professor Kratz.

President Howatt announced that he had received reports indicating that the registration at that time was 945 and pointed out that the veterans who were attending the meetings year in and year out would realize how gratifying that registration was to the Illinois Chapter and those who worked to make it a success.

The session adjourned at 12:25 p. m.

THIRD SESSION—

Wednesday, January 29, 1936, 9:30 A. M.

President Howatt opened the session and stated that the first presentation of the morning would be a paper entitled, Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, by G. L. Tuve. (Complete paper published in December, 1935, Journal Section, *Heating, Piping and Air Conditioning*). Written discussions of the paper were then submitted by R. H. Norris, Schenectady, F. G. Hechler and F. C. Stewart, State College, Pa., which were read by John James. Open discussion followed with the following members participating: Prof. F. B. Rowley, J. N. Hadjisky, Birmingham, Mich., and L. O. Monroe, Detroit, all of which were answered by Professor Tuve.

President Howatt then announced that one of the pro-

gressive steps taken by the Society during the past year was to make arrangements for a Chapter Officers meeting at the Annual Meeting. F. C. McIntosh, Chairman of this group, presented to the convention the following Chapter representatives: Cincinnati, G. B. Houliston; Cleveland, Prof. G. L. Tuve; Illinois, J. H. Milliken; Kansas City, C. A. Weiss; Manitoba (New Canadian Chapter), C. H. Turland; Massachusetts, W. A. McPherson; Minnesota, C. E. Gausman; Michigan, A. C. Wallich; Western Michigan, Prof. L. G. Miller; New York, W. W. Timmis; Western New York, W. E. Voisinet; Oklahoma City (New Chapter), Prof. E. R. Dawson; Ontario, M. W. Shears; Pacific Northwest, Lincoln Bouillon; Philadelphia, J. H. Hucker; Pittsburgh, T. F. Rockwell; St. Louis, C. R. Davis; Southern California, Leo Hungerford; Washington, D. C. (New Chapter), W. A. Danielson; and Wisconsin, C. H. Randolph.

Prof. G. L. Larson then assumed the chair and introduced the next speaker, L. P. Herrington, New Haven, who presented the paper entitled, Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions, by C.-E. A. Winslow and L. P. Herrington. (Complete paper published in November, 1935, Journal Section, *Heating, Piping and Air Conditioning*). The paper was then followed with a discussion by S. L. Haas, Chicago, Dr. E. V. Hill, Chicago, J. N. Hadjisky, W. A. Danielson, Dr. Burton Rogers, Chicago, F. W. Legler, Minneapolis, and the various queries were answered by Mr. Herrington.

The gavel was returned to President Howatt who announced that twelve past presidents were in attendance at the meeting and he then introduced them individually to the members: Dr. A. C. Willard, Prof. F. B. Rowley, W. T. Jones, W. H. Driscoll, S. R. Lewis, H. M. Hart, Dr. E. V. Hill, John F. Hale, Homer Addams, Prof. James D. Hoffman, J. I. Lyle, and Charles V. Haynes.

The cooperative research paper reporting the work done at the School of Public Health, Harvard University, in cooperation with the Society's Research Laboratory was presented by Prof. C. P. Yaglou, Boston, entitled, Ventilation Requirements, by C. P. Yaglou, E. C. Riley and D. I. Coggins. (Complete paper published in January, 1936, Journal Section, *Heating, Piping and Air Conditioning*).

In the discussion which followed President Howatt stated that this paper was of practical interest to those individuals engaged in school work and further pointed out that the Chicago school engineers group contributed in a material way in making this piece of research possible.

John D. Cassell, Philadelphia, Life Member and member of the Council for six years, discussed the paper in relation to his own observations of the codes now existing in the State of Pennsylvania. Additional comments were offered by N. W. Downes, Kansas City, G. P. Ellis, Pittsburgh, J. N. Hadjisky, S. R. Lewis, Chicago, J. J. Aeberly, Chicago, W. H. Driscoll, New York, S. L. Haas, J. H. Van Alsburg, Holland, Dr. E. V. Hill, W. F. Christman, Chicago, A. W. Shepherd, New York, and E. V. Fineran, Washington, D. C. A detailed reply to the various questions was given by Professor Yaglou.

The paper, Airfoil Fan Characteristics, by W. A. Rowe, Detroit, was presented by the author. (Complete paper published in February, 1936, Journal Section, *Heating, Piping and Air Conditioning*). A written discussion was presented by Prof. A. I. Brown, Columbus, O.

The meeting adjourned at 12:35 p. m.

FOURTH SESSION—

Wednesday, January 29, 1936, 2:00 P. M.

A joint meeting with the *National Warm Air Heating and Air Conditioning Association* was held at the Stevens Hotel with Pres. H. T. Richardson of the *N. W. A. H. & A. C. Association* and Pres. John Howatt of the A. S. H. V. E. presiding jointly as chairmen. In opening the session Chairman Richardson greeted the members and welcomed the A. S. H. V. E. whose interest in heating, ventilating and air conditioning indicated that many of the objectives of the two organizations were of mutual interest in the air conditioning field.

President Howatt cordially responded to these greetings and discussed the problems of common interest which the leading technical organizations in this country are striving to stimulate in the air conditioning industry. He discussed the fact that these problems dealing with air conditioning could be classified in two general ways, first, those problems which related to the determination of the proper air environment for the human system based upon physiological effects and human reactions, and the second group of problems dealing with the best methods of obtaining these objectives. He pointed out that the first group of these problems dealt with fundamental research and that the other group was more specifically concerned with the application of the best known principles of air environment. The greatest differences of opinion of societies now engaged in this field seem to be based upon the second set of problems and President Howatt felt that these issues were natural, due to the industry moving so rapidly into the field. As time goes on he felt that these differences of opinion would level out and eventually all would come to a common understanding with some best practice applicable for obtaining the most desirable inside human environments. In closing he remarked that the members of the A. S. H. V. E. were happier, in his opinion, at this meeting than they had been for several years and he hoped that the members of the other association meeting jointly on this occasion would have the same experience.

Chairman Richardson introduced the President-elect of the A. S. H. V. E., Prof. G. L. Larson, and the secretaries of the two organizations, A. V. Hutchinson of the A. S. H. V. E. and Allen W. Williams of the *N. W. A. H. & A. C. Association.*

Chairman Richardson then presented the gavel to Pres. John Howatt and he introduced W. C. Randall, who presented the paper entitled, Room Surface Temperature of Glass Windows, by J. E. Emswiler and W. C. Randall. (Complete paper will be published in the Journal Section, *Heating, Piping and Air Conditioning*). Comments on this presentation were offered by John James, Prof. F. B. Rowley and R. E. Hattis, Chicago.

Prof. A. P. Kratz was introduced and gave an outline of the A. S. H. V. E. research program. In opening his discussion he also indicated the common background which the two organizations have and particularly stressed the primary interest they have in research and in this respect he pointed out that the two societies have actually joined hands in cooperative research projects in

such fields as summer cooling. He outlined the research activities of the A. S. H. V. E. in relation to its organization which is governed by a group of members elected to engage in the supervision of individual projects carried out at the Research Laboratory, located at Pittsburgh, Pa., and with the cooperation of the various universities and institutions functioning under cooperative agreements with the Society. The work of the several technical advisory committees of the Society was then discussed. (Remarks referred to Report of the Committee on Research published in February, 1936, Journal Section, *Heating, Piping and Air Conditioning*).

President Howatt passed the gavel of authority to President Richardson, who then introduced Dr. A. C. Willard to the joint session. F. G. Sedgwick was presented and as Chairman of the Research Advisory Committee of the *N. W. A. H. & A. C. Association* gave a formal report on activities of that committee.

It was announced by J. H. Van Alsburg that the *N. W. A. H. & A. C. Association* would hold their 5th annual short course on forced warm air heating and air conditioning at the Michigan State College, East Lansing, Mich., March 31 to April 3, inclusive.

Chairman Richardson presented S. Konzo, who gave a progress report illustrated with slides on Residence Cooling Using Water from City Service Mains based upon results obtained at the Research Residence located in Urbana, Ill.

The meeting adjourned at 4:55 P. M.

FIFTH SESSION—

Thursday, January 30, 1936, 9:30 A. M.

Immediately after calling the session to order President Howatt introduced F. C. Houghten, who presented the paper entitled, Comfort Standards for Summer Air Conditioning, by F. C. Houghten and Carl Gutberlet. (Complete paper published in November, 1935, Journal Section, *Heating, Piping and Air Conditioning*).

At the completion of the formal presentation of the paper President Howatt stated that in nearly all of the Society Chapters during the months of November and December this paper was presented for detailed consideration. Many written discussions were prepared and due to the length of these manuscripts they were not presented before the meeting but it was announced that they would be included in the annual Transactions compiled by the Society. Individual comments on the paper were offered by Cyril Tasker, Toronto, Prof. F. B. Rowley, L. T. Avery, Cleveland, S. L. Haas, J. N. Hadjisky, J. J. Aeberly and W. L. Fleisher, New York.

J. H. Hucker of the Philadelphia Chapter was presented and extended a cordial invitation to members of the Society to meet with them at the joint summer meeting of the *American Society of Refrigerating Engineers* and the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS to be held at Buck Hill Falls on June 22, 23 and 24, 1936.

S. R. Lewis was appointed Chairman *pro tem* of the meeting and instructed W. T. Jones, past president of the Society, to conduct the installation of Officers. A. V. Hutchinson, Secretary, was appointed marshall and instructed to escort to the rostrum the outgoing members of the Council, R. H. Carpenter, J. D. Cassell, C. V. Haynes, F. C. McIntosh, and L. W. Moon. Then the incoming members of the Council were presented and escorted to the front of the room by Mr. Hutchinson: R. C. Bolsinger, S. H. Downs, W. L. Fleisher and C. M. Humphreys.

The formal installation of officers followed with the President-Elect, Prof. G. L. Larson, Madison, being presented by Prof. F. B. Rowley; First Vice-President, D. S. Boyden, Boston, was introduced by W. H. Driscoll; Second Vice-President, E. H. Gurney, Toronto, was introduced by H. M. Hart, and the Treasurer, A. J. Offner, New York, was introduced by C. V. Haynes.

The final paper of the session entitled, Corrosion Studies in Steam Heating Systems, by R. R. Seeber, F. A. Rohrman and G. E. Smedberg, was offered for presentation by R. R. Seeber, Houghton, Mich. H. M. Hart, Chicago, and W. H. Driscoll commented on the importance of this paper and, due to the fact that there was insufficient time for the proper discussion of the paper, it was regularly moved by J. D. Cassell and carried unanimously that the paper be presented at the next meeting of the Society.

President Larson presented M. K. Fahnestock, Urbana, who read a proposed revision to the Code for Testing and Rating Indirect Gravity Convectors which refers specifically to a change in exponent from 1.3 to 1.5 for the steam and hot water codes. Mr. Fahnestock moved that the Society proceed with the necessary constitutional method for adoption of these changes and the motion was carried unanimously.

Resolutions

R. H. Carpenter, New York, was introduced to the meeting and offered the following resolutions:

RESOLVED, that our sincere thanks, appreciation and continued interest be and hereby are, extended:

To the *Illinois Chapter*, our gracious host, who through its able and efficient committees has shown its boundless hospitality so well, and has done so much to make this meeting thoroughly enjoyable from every standpoint.

To the *City of Chicago* and its capable and genial Mayor Kelly, who gave us such a hearty and kindly welcome.

To the *Association of Commerce*, who stood so solidly behind our local chapter in urging us to meet here, and for its assistance in making our stay so pleasant.

To the *Management of the Palmer House*, which has once more demonstrated its ability to look after our every need in making us comfortable.

To the *Press*, both trade and daily, for the fine amount of publicity given the Society and its activities both before and during this meeting.

To all the *Exhibitors* of the Fourth International Heating and Ventilating Exposition, and to C. F. Roth, the exposition manager, for their helpful cooperation in coordinating their activities with our own during this meeting.

To the *Saddle and Sirloin Club* for its thoughtful courtesy in entertaining our Council so royally during its Monday meeting, and also for the extending of guest privileges to us.

To the *American Rolling Mill Company* for its radio tribute to the air conditioning industry during their nationwide broadcast last evening, and

To the *Railroads and City Transportation Companies* for their helpful and efficient handling of transportation arrangements for members and guests.

Committee on Resolutions,
R. H. CARPENTER.
J. D. CASSELL.
W. T. JONES.

The meeting adjourned at 12:20 P. M.

Some of the exhibits at the Fourth Heating and Ventilating Exposition

Exposition Attracts Fifty Thousand Visitors

FEATURED by an unusual amount of interest on the part of some 50,000 visitors in products displayed by over 300 exhibitors, the Fourth International Heating and Ventilating Exposition—The Air Conditioning Show—held in the International Amphitheatre, Chicago, January 27-31, was voted the best ever by the industry and the public alike. Those in attendance were particularly impressed by the type of visitors who came to see and to learn—questions about the features, operation and application of the equipment on display (and in many cases in operation) were intelligent and were searching. Sales were definitely up. Many manufacturers lined up contacts which otherwise would have taken weeks of travelling and correspondence.

The exposition, held during the same week as was the 42nd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the mid-winter meeting of the *National Warm Air Heating and Air Conditioning Association*, was particularly impressive and there was evidence of a business-like desire to learn on the part of those who came to the show, and the displays offered were designed to answer this demand for knowledge.

The displays included almost every type of device used in heating and ventilating, and in both the residential and the industrial and commercial air conditioning fields—steam and hot water boilers, furnaces, boiler-burner and furnace-burner units, central and unit air conditioning, controls, valves, pumps, traps, oil burners, stokers, gas burners, heating surface, radiation, unit heaters and coolers, water heaters, insulation, pipe, sheet metal, refrigerating machines and accessories, fans and blowers, air filters, instruments, tools, welding apparatus, motors, drives, registers and grilles, to name but a few. Little was neglected, either in the range of the exhibits or in attention given them by those who came.

The Society maintained an information service at Booth 8 during the Exposition. THE GUIDE 1936 made its first initial public appearance during the Show.

The A. S. H. V. E. Research Laboratory (Booth 20) displayed apparatus for measuring the intensity of the sun's rays for several types of test specimens to indicate the comparative reflectivity and insulating qualities of the various materials. A device for measuring the condensation resulting from copper, iron and covered pipes was shown, and attracted the attention of many engineers who visited the Show. Photographs of test equipment used at the various institutions engaged in cooperative research with the Society were illustrated on the several panel walls surrounding the booth, indicating to the observer the abundance of informative data on any subject which an investigator may desire in the field of heating, ventilating and air conditioning.

Many Working Demonstrations

Much thought was given by those who exhibited to show actual demonstrations of their products, or to indicate by means of models and test set-ups, their features and applications. One exhibitor (Streamline Pipe and Fittings Co.) attracted crowds all during the week with demonstrations of how streamline copper tube fittings are installed. In addition to the demonstrations, a complete line of copper pipe and solder type valves and fittings was shown, including a full flow packless valve for refrigeration. A popular feature at this booth was a guessing contest, and many visitors attempted to estimate the number of fittings used on large jobs, one of which was illustrated each day. In a booth showing a line of insulation products (Keasbey & Mattison Co.), a novel display to show the effectiveness of insulation on pipes was featured. Steam flowed through insulated and non-insulated pipes, and the amount of power generated by the steam in each case was indicated. A new product at this booth was an insulating cement for boilers which is economical in first cost and which can be re-used. This exhibitor reported a great deal of interest on the part of apartment owners in insulation because of the sub-zero temperatures in Chicago during the first day or two of the show. One apartment building manager said it took 18 lb steam pressure to get steam to the fourth floor before covering was applied to the piping.

A manufacturer of a complete line of automatic heating and air conditioning equipment (Delco-Frigidaire Conditioning Corp.), showed a miniature air conditioning system in operation, with the equipment clearly labelled and pressures indicated by dials. Features of the set-up were a crank case pressure regulating valve which maintains normal loading on the motor under rising load conditions, and an evaporator pressure regulating valve to maintain proper evaporator temperature under diminishing load. At the booth of a manufacturer (Johnson Service Co.) of a complete line of automatic temperature and humidity controls, a full size central station air conditioning system was shown, with actual controls and piping. Illuminated sections of this display explained operation of the system and the controls.

At another booth (Frick Co.), a new 20 ton Freon compressor with four cylinders was turned over slowly by a reduction gear motor to show action of the valves, lubricating system, and other parts. A full size direct-fired heating unit for industrial plants, equipped with an oil burner (Lammert & Mann), was in operation throughout the week at one exhibit (Dravo-Doyle). A thermometer showed readings of stack temperatures, which were held down to 260 deg. The unit was rated 750,000 Btu per hour. Attached to the side of the unit was a table showing results of an actual test which had been run at a steel plant where 101 of these units are used; CO_2 averaged 14.7 per cent with zero CO.

Dominating the exhibit of a manufacturer of electrical controls (Minneapolis-Honeywell Regulator Co.), was a complete and beautifully finished model of a central station air conditioning system, controls being shown in the occupied space and below it, a miniature cooling plant. Switches on the front of the display enabled spectators to operate the equipment, and served to show the importance of complete control of temperatures and humidity. The center of interest at an electrical and air conditioning manufacturing company's booth (Westinghouse Electric & Mfg. Co.) was a working model of a method of cleaning air electrically, which attracted many medical men, home owners, and others. Power required to operate such a device in a home, including a fan for drawing the air over it, is about the same as required for a domestic refrigerator. The unit removes small particles, and has been found to be helpful in relieving asthma patients irritated by various dusts. Also at this same booth was a splash-proof motor in a glass tank which operated continuously during the week though sprayed with water from all directions. A complete line of motors, air conditioning units and compressors completed the display.

One exhibitor (Julien P. Friez & Sons) found great interest in the tools of the industry which were displayed—that is, the instruments which indicate and record the results achieved by an air conditioning system, and which enable proper installation and adjustment of the system. Among the products, in addition to a complete line of weather and control instruments, was a new hand aspirated psychrometer, compact and light in weight, for taking wet and dry bulb readings. The instrument may be operated in small space and inconspicuously. By means of a rubber bulb, air is drawn by the venturi principle across the bulb of the wet bulb thermometer. Another feature at this same booth was a working model of a method of transmitting direct readings of relative humidity at any distance by means of a system using two synchronous motors, one at the point where the relative humidity is measured by a human hair element, and the other where it is desired to be read. To show how its instruments worked, this exhibitor displayed a small glass chamber which could be humidified, dehumidified, heated and cooled when the visitor pressed the proper switch.

An illuminated cabinet with magnetic valves arranged for operation demonstrated the thermo valves of one exhibitor (Alco Valve Co.), and a special hook-up showed how heat and year 'round supply of domestic hot water can be supplied from one fire at another booth (American Radiator Co.). Sheet metal duct work formed a frame around another display (American Rolling Mill Co.), demonstrating fabrication details. A duplex vacuum heating pump (American Steam Pump Co.) in operation was alternated by controls (W. P. Whittington, Inc.). A five room house piped with neon tubing and glass bowl radiators showed controlled distribution through a water column with air valves (Anderson Mfg. Co), and a glass model of a trap operating at 5 lb steam pressure showed how the trap handled dirt and air as well as condensate in another booth (Armstrong Machine Works), with another glass model of the trap incorporating the automatic air bypass.

General view of a section of the Heating and Ventilating Exposition

Looking across two aisles in the International Amphitheatre at some of the exhibits

A refrigerating machine in operation, attached to an air conditioning furnace unit (Fox Furnace Co.) demonstrated cooling, and an animated device at another booth (Hoffman Specialty Co.) showed the variable venting speeds possible by means of simple adjustment of a new adjustable orifice vent port on radiator valves. Active working demonstrations of its humidifiers, water feeders, low water cut-outs and circulating pumps were on display by another exhibitor (Maid-O-Mist, Inc.).

Visitors could operate at one display (Jas. P. Marsh Co.) a system of temperature regulation in a model of a miniature building and heating plant, to demonstrate the manner in which the control operates with varying outside weather conditions, and at another booth a new copper heating surface (John J. Nesbitt, Inc.) was shown under actual operating conditions. The circulation of water through a one-pipe main in which shunt tees were installed to demonstrate circulation from main to radiator was featured at another booth (Stevens-Root Co.). Oil burners and fuel oil pumping and preheating equipment were well represented by operating displays. One manufacturer (Sundstrand Machine Tool Co.) showed a single-stage pump in operation, the pump being automatically started and stopped, and another (Viking Pump Co.) showed fuel oil pumping units, also in operation. Operation of heat controlled steam systems was illustrated by a continuous talking exhibit (C. A. Dunham Co.).

The steel companies, manufacturers of pipe and sheets used in the heating, ventilating and air conditioning industry, were on hand, with particularly educational and elaborate displays. One exhibitor (Jones & Laughlin Co.) had a complete model of a blooming mill, some 15 ft long, in operation, which was the center of a good deal of interest. In the front of this booth was a table on which was displayed sections of some 18 or 20 different kinds of pipe, each identified. Another (Youngstown Sheet & Tube Co.) featured a complete working model of a new 79 in. hot continuous sheet mill, and at yet another booth (Bethlehem Steel Co.) a moving exhibit of steel sheets greeted the eye.

New Products Introduced at Show

Manufacturers took the opportunity to introduce to the buying public and the industry a great many new products, and improvements and refinements in design of old ones. Among these were devices in operation, particularly unit heaters, unit coolers,

Displays at the Heating and Ventilating Show

and air conditioning units for every type of application—industrial, commercial and residential. One exhibitor (Burnham Boiler Co.), who also showed a line of modern appearing, compact radiation and steel and cast iron boilers, and new unit air conditioners which may be used for modernization by replacing radiators, attracted visitors with an electric steam radiator, portable and compact, for hard-to-heat places in offices, hotels, apartments, homes and other buildings.

Another new product was a unit heater (American Blower Corp.), the first to have sound ratings, and another manufacturer (American Radiator Co.) showed new air conditioners, air filters, rapid venting valves with half-inch venting port for use on steam mains and an adjustable orifice venting valve for radiators on one-pipe steam and vacuum heating systems. A new propeller fan embodying a non-overloading power feature was displayed by one exhibitor (Autovent Fan & Blower Co.), and another booth (Bell & Gossett Co.) featured an improved tankless heater and many innovations in hot water heating specialties. A high power valve operator made for either high or low voltage operation and a new oil-immersed damper control motor rated at 1,000 lb-in. torque attracted many to a control maker's booth (Barber-Colman Co.), and a pump maker introduced a compact, close-coupled centrifugal pump, 3 to 600 gpm against heads up to 189 ft (Chicago Pump Co.).

A new type thermostat (Detroit Lubricator Co.), new asbestos cement for setting up furnaces, stoves and retorts (Fireline Stove & Furnace Lining Co.), new oil- and coal-fired residential steel boilers, equipped with domestic hot water coils for summer and winter use (Fitzgibbons Boiler Co.), and a coal-burning and a gas-fired air conditioning furnace unit (Fox Furnace Co.) were among the other new products offered.

A completely automatic coal burning heating plant, using pulverized coal (Gaskoal Corp.), was an adaptation of central plant practice to apartment and residential heating.

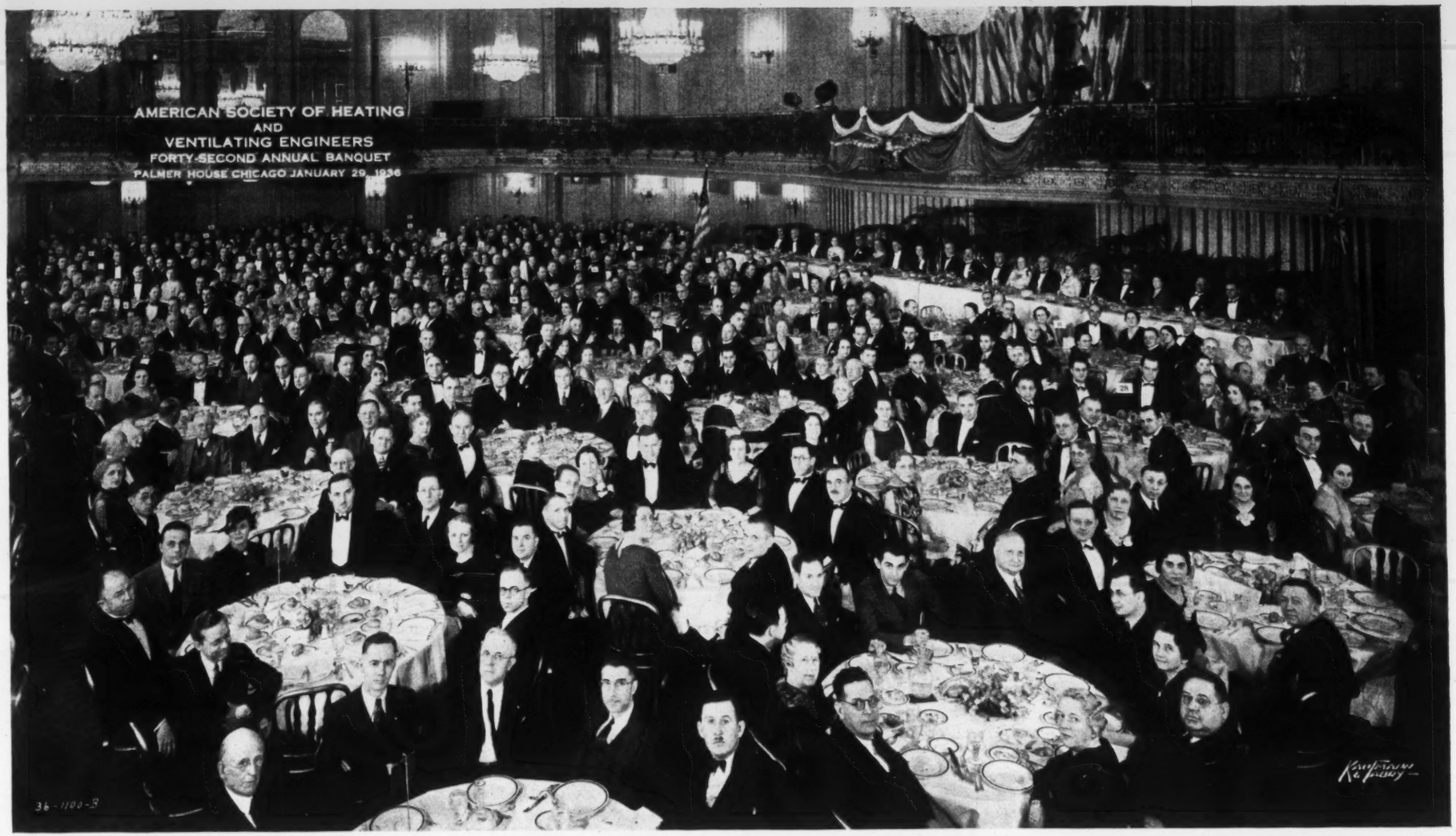
Among the wide range of equipment shown for the first time was a portable electric heater and a portable electric humidifier (Hexcel Radiator Co.), a new line of radiator traps and combination float and thermostatic traps (Illinois Engineering Co.), a six stage air conditioning furnace unit (Joliet Heating Corp.), a new oil fired winter air conditioning unit for homes (Meyer Furnace Co.), and an oil fired air conditioning furnace and a gas fired boiler (L. J. Mueller Furnace Co.). An instrument maker featured a new duct jet for a direct reading air velocity meter (Illinois Testing Laboratories, Inc.) which was a center of interest to those concerned with the installation and testing of air conditioning and ventilating systems, and forced air heating jobs. Quieting air conditioning ducts was stressed in a display of recently developed air acoustic sheets by an insulation manufacturer (Johns-Manville). Another exhibitor (Wood Conversion Co.) featured a new balsam wool duct insulation, which has been developed because of the increased attention being given to insulation of air conditioning duct work. A new line of blower wheels and housings was featured at another booth (Lau Heating Service, Inc.).

Copper tube and fin heat transfer surface employing two steam distributing tubes inside each of the regular condensing tubes for better steam distribution and improved control featured an attractive display, and the first group of new automatic controls for heating, ventilating, air conditioning and refrigeration (Perfex Controls Co.) were featured at another. Other products were a double reservoir, the upper entirely separate from the lower, self aligning, self lubricating pillow block (Randall Graphite Products Corp.); a new spray humidifier with new self cleaning spray nozzle for use with warm air furnaces (Rega Mfg. Co.); a domestic humidifier for installation in the smoke pipe of a warm air furnace (Rochester Mfg. Co., Inc.); new oil burner controls, new stoker controls and a new dehumidifying liquid (Russell Electric Co.); graduator system of temperature control designed to control temperature of large buildings directly by the weather (Sarco Co., Inc.); a tankless hot water heater and a multi-coil indirect heater (Taco Heaters, Inc.); new pressure oil burner and new series of oil burning boilers (Timken Silent Automatic Co.); a rekindling control with automatic over-heat prevention for stokers and a new line of clock controlled switches for use with single or dual thermostats (Tork Clock Co., Inc.).

A device for use in ducts to permit the use of all right angle elbows throughout the system and a volume control device which also provides uniform distribution of air over a grille surface, featured one display (Tuttle & Bailey, Inc.), and a new line of diffusional and directional flow air conditioning registers was shown by another exhibitor (United States Register Co.). Other products on display comprised oil burning water heaters (Viking Mfg. Co.); oil burning furnace and air conditioning units (Waterman-Waterbury Co.); air conditioning units for use with boiler and radiator heating (Weil-McLain Co.); new close coupled pumps (Weil Pump Co.); instantaneous thermostats for unit heaters and coolers, a dual type thermostat and a new weather control for heating systems (Wilbin Instrument Corp.); small, low priced belt driven and direct connected centrifugal pumps and new line of deep well turbine pumps in operation (Worthington Pump & Machinery Corp.), and an indoor cooling tower developed to minimize water consumption on small air conditioning systems and a re-designed air conditioning unit (York Ice Machinery Corp.).

One exhibitor (York Oil Burner Co.) featured an oil burner with positive air control. Exhibited by a manufacturer (Ric-wiL Co.) of a complete line of underground steam conduit was a unit steam main which comes in 13 ft lengths and is of welded construction. Handling and installation costs are reduced, as less excavation for trenches is required and fewer joints are necessary due to the longer lengths. The insulation used was immersed in water to show its resistance to damage.

Across one end of the exhibit hall was shown a complete line of air conditioning units and compressors, with a beautifully finished compressor in a glass case with portions cut away, so that observers might see the details of operation (Kelvinator Corp.). A stoker manufacturer (Burke Stoker & Mfg. Co.) showed two models of its stoker, and attention was called to the fact that these were of the same type used in connection with a large steam jet refrigeration air conditioning installation in Chicago. At another booth (Wilson & Co.) an interesting display of insulation unaffected by heat, cold or water was exhibited, with water running over the animal hair material used as the insulating material. Low cost, throw away type filters were also shown by this same manufacturer. An illuminated display at one large booth (Ingersoll-Rand Co.) showed the operation of two types of water vapor refrigeration compressors for air conditioning applications; one, the steam jet type, and the other, the centrifugal machine.



42nd Annual Banquet, American Society of Heating and Ventilating Engineers, Grand Ballroom, Palmer House, Chicago, Ill., January 29, 1936

At the Speakers' Table: C. F. Roth, J. H. Milliken, A. J. Offner, Miss Virginia Anderson, H. T. Richardson, Mrs. S. R. Lewis, Dr. A. C. Willard, Mrs. G. L. Larson, John Howatt, O. J. Prentice, Maj. J. L. Griffith, Mrs. John Howatt, Prof. G. L. Larson, Mrs. J. H. Milliken, S. R. Lewis, D. S. Boyden, Mrs. J. P. Fleming, A. W. Williams, R. L. Dadisman, and J. P. Fleming.

Entertainment in Chicago

THE BIG WEEK in Chicago at the 42nd Annual Meeting of the A. S. H. V. E. will long be remembered by the members, ladies, and guests who were present, and a fine program of entertainment during the four-day meeting was planned by the Committee on Arrangements of Illinois Chapter under the leadership of J. H. Milliken, chairman, assisted by J. J. Hayes, vice-chairman, and the committee members.

Reception and registration began at 9:30 a. m. on Monday, January 27, in the foyer of the Red Lacquer Room of the Palmer House, and throughout the meeting members of the Reception Committee, headed by J. R. Vernon, were on hand to extend a welcome to Chicago and render assistance to the visitors.

At 12:30 p. m. on Monday all of the Council members were present at a luncheon in the Saddle and Sirloin Club, Stock Yards Inn, and later took part in the formal opening of the Fourth International Heating and Ventilating Exposition at the International Amphitheatre at 2:00 p. m.

The entertainment of ladies was handled by a special committee with C. F. Hayden as chairman. The first social event was an informal tea on Monday afternoon in the Illinois Chapter Room, which was furnished as an attractive lounge and club room.

On Monday evening at 8:30 members and ladies assembled in the Illinois Chapter Room for an informal reception and enjoyed the entertainment provided by Miss Alice Blue, pianist of Station WGN. Tom Brown and the Entertainment Committee were in charge.

At 10:30 a. m. on Tuesday, January 28, ladies assembled for a visit to the Chicago Art Institute and 75 were present at a luncheon and style show at Marshall Field & Co. at 1:00 p. m.

A Get-Acquainted Luncheon for members and guests was held in the Chicago Room of the Palmer House on Tuesday at 12:30 p. m. Twelve past presidents of the Society were in attendance at the meeting and eight assembled together at their annual dinner held on the evening of January 28, in the Palmer House. The twelve present were Homer Addams, W. H. Driscoll, J. F. Hale, H. M. Hart, C. V. Haynes, Dr. E. V. Hill, Prof. J. D. Hoffman, W. T. Jones, S. R. Lewis, J. I. Lyle, Prof. F. B. Rowley, and Dr. A. C. Willard.

One of the most enjoyable features arranged for by the Entertainment Committee was the House-Warming Party in the Red Lacquer Room on Tuesday, when dancing began at 10:00 p. m. Music was supplied by The Broadcasters and entertainment was provided by Norman Ross and his NBC amateurs. Adding to the gaiety of the party was the Paul Jones called by Tom Brown.

On Wednesday, January 29, the ladies were taken on a tour of the Adler Planetarium at 10:45 a. m. In the afternoon they held forth at Bridge in the Illinois Chapter Room and, in spite of a multitude of last minute things to do and places to go, several tables were arranged. High and second high scores were awarded with a prize. Mrs. G. G. Turner, who was in charge, was assisted by Mrs. J. P. Fleming, Mrs. E. P. Heckel, and Mrs. J. R. Vernon.

The outstanding social event of the meeting was the Annual Banquet and Dance on Wednesday, at 7:00 p. m. in the Grand Ballroom of the Palmer House, which was beautifully decorated and contained the flags of the United States and Great Britain on each end of the speakers' table. O. J. Prentice was toastmaster. One of the features was the broadcast by Pres. John Howatt over NBC's blue network as guest speaker on the Armco program dedicated to Air Conditioning.

While dinner was being served, stirring vocal selections were rendered by the Original Old Heidelberg Octette.

A notable event of the meeting was the presentation of the F. Paul Anderson Medal to Dr. A. C. Willard, president of the University of Illinois and past president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. President Howatt made the presentation to Dr. Willard before a group of 715 members and friends who attended the annual banquet.

H. T. Richardson, president of the *National Warm Air Heating and Air Conditioning Association*, was introduced and in a fine tribute to Dr. Willard, who has had an active part and interest in the research of both organizations, he presented a token of the Association's esteem.

President Howatt then received the medal presented to Past Presidents of the A.S.H.V.E., the emblem being presented by Samuel R. Lewis.

Competition in Athletics and Business was the title of an address by Maj. John L. Griffith, who was introduced by the toastmaster.

At the conclusion of the Banquet program, members and guests adjourned to the Red Lacquer Room, where dancing was enjoyed to the music of Waddy Wadsworth and his band.

J. P. Fleming and his committee in charge of the banquet received many words of praise for their successful management.

During the meeting transportation arrangements were under the direction of B. L. Casey and his committee. Buses left the Palmer House at frequent intervals for the International Amphitheatre and on Monday, Tuesday and Thursday afternoons technical sessions were omitted so that members would have ample opportunity to view the Exposition. On Thursday afternoon and Friday morning inspection trips to manufacturing plants were made possible.

The finances of the Chapter in connection with the meeting were ably handled by E. W. Rietz and his assistants and the Society enjoyed an unusual amount of publicity in the trade and daily papers, due to the effective work of the Publicity Committee with C. E. Price as chairman.

The spirit of enthusiasm and interest which was prevalent and the many favorable comments received attest to the outstanding success of the Society's 42nd Annual Meeting.

Committee on Arrangements

Chairman—J. H. Milliken; *Vice-Chairman*—J. J. Hayes.

Publicity—C. E. Price, *Chairman;* L. W. Britton and G. G. Turner.

Reception—J. R. Vernon, *Chairman;* O. W. Armspach, C. W. DeLand, J. J. Haines, R. E. Hattis, H. R. Linn, A. B. Martin, J. C. Matchett, Eugene Mathis, H. P. Reid and J. M. Stannard.

Ladies—C. F. Hayden, *Chairman;* Mrs. B. L. Casey, Mrs. C. W. DeLand, Mrs. J. P. Fleming, Mrs. T. F. Hanley, Mrs. C. F. Hayden, Mrs. J. J. Hayes, Mrs. E. P. Heckel, Mrs. F. P. Keeney, Mrs. J. C. Matchett, Mrs. J. E. McClellan, Mrs. E. N. McDonnell, Mrs. J. H. Milliken, Mrs. R. E. Moore, Mrs. L. L. Narowetz, Jr., Mrs. C. E. Price, Mrs. F. I. Raymond, Mrs. Lester Ries, Mrs. S. I. Rottmayer, Mrs. A. G. Sutcliffe, Mrs. G. G. Turner and Mrs. J. R. Vernon.

Transportation—B. L. Casey, *Chairman;* E. M. Mittendorff and F. C. Warren.

Entertainment—Tom Brown, *Chairman;* C. E. Crone, Jr., W. G. Jennings, H. G. Kreissl, E. N. McDonnell, E. T. Murphy, L. L. Narowetz, Jr., and L. W. Washington.

Banquet—J. P. Fleming, *Chairman;* J. J. Aeberly, J. R. Borling, A. E. Christophersen, J. J. Finan, R. M. Getschow, T. F. Hanley, Jr., R. B. Hayward and H. B. Hinckley.

Finance—E. W. Rietz, *Chairman;* E. J. Gossett and S. M. Trumbo.

Advisory—J. F. Hale, H. M. Hart, Dr. E. V. Hill and S. R. Lewis.

New York Consulting Engineers Elect A. J. Offner

Alfred J. Offner, consulting engineer, New York, N. Y., national treasurer of the Society and member of the Council, has been elected president of the *New York Association of Consulting Engineers* for the year 1936.

Illinois

February 10, 1936. Pres. J. H. Milliken called the February meeting of Illinois Chapter to order in the Hotel Sherman, Chicago, at 8:00 p. m., with an attendance of 87. L. S. Ries, secretary, gave a brief report of the January meeting, at which Prof. A. H. Compton was the guest speaker.

President Milliken welcomed A. P. Brown and W. H. Baker, Jr., into Illinois Chapter, and presented C. A. Viall and J. B. May as new limited members.

An invitation from the *Air Conditioning Engineering Society* to attend their meeting February 21 was read.

President Milliken reported on the 42nd Annual Meeting of the Society, January 27-30, at the Palmer House, Chicago, when the Illinois Chapter was host to A. S. H. V. E. and stated that the meeting was a success in every way, judging from the many kind comments sent to the Chapter. He announced also that a record registration of more than 50,000 was reported at the Heating and Ventilating Exposition, held at the International Amphitheater. A communication was read from John Howatt, retiring national president of the A. S. H. V. E., thanking the members who participated in the work of welcoming other Chapter members to Chicago.

Mr. Howatt was called upon and made a brief stirring address.

Letters from C. F. Roth, manager of the International Heating and Ventilating Exposition, and Prof. F. B. Rowley, University of Minnesota, thanked the Chapter for the manner in which the Annual Meeting was handled.

S. R. Lewis, past president of the A. S. H. V. E., was introduced by President Milliken, and presented M. P. Winther, rail car engineer, the speaker of the evening.

Mr. Winther discussed Air Conditioning of Passenger Cars and stated that originally conditioning of air in passenger cars was done by recirculating 75 per cent of the air and introducing 25 per cent of fresh air. This arrangement was modified until today the damper in the air supply grilles can be set so that only 10 per cent of the air is recirculated and 90 per cent is fresh. Each car requires approximately six tons of refrigeration capacity, averaging from 10 to 15 hp. The history of the refrigerant, Freon, was outlined as well as the method used. Mr. Winther exhibited slides showing the location of twin blowers in the skeleton car structure, ducts, grilles, cooling coils, compressors, drives, motors, etc.

He explained that passenger cars are subjected to the severest possible conditions, inasmuch as in one trip they may go through hot dust storms and through a blizzard, and wind up in a torrential rain storm. Each car is supplied with 80 to 100,000 cu ft of air circulation per hr. For conditioning this air the power is taken from one of the truck axles by means of a powerful V-belt drive with the jackshaft located at the end sill of the truck. The jackshaft drives a set of bevel gears which in turn transmit the power to an electro-magnetic governor by means of a flexible propeller shaft. This electro-magnetic governor is a pullman feature which makes possible an even flow of energy to the air conditioning equipment irrespective of the speed of the car. The temperature in the car is kept at 71 to 76 deg by means of a thermostat which actuates the compressor. Air is delivered at the grilles in the summer at a temperature of 60 to 66 deg and maintains a relative humidity in the car of about 50 per cent. The weight of this equipment is about 8500 lb. Mr. Winther also described the vapor system for heating purposes.

By means of this system a complete air conditioning program is furnished each car, that is, air is heated when required, cooled when required, filtered and the moisture content of the delivered air controlled.

In answering questions by members, Mr. Winther stated that at present about 3500 pullman cars are air conditioned and that there has been spent approximately $50,000,000 for air conditioning of passenger cars to date.

Two excellent reels showing the Union Pacific Railroad streamlined articulated air conditioned train trip were shown.

President Milliken introduced the following guests, Messrs. Hupp, Gundermann, and Jordan, before the meeting adjourned at 9:35 p. m.

Manitoba

January 23, 1936. The January meeting of the Manitoba Chapter was held at the Fort Garry Hotel, Winnipeg, and dinner was served at 6:15 p. m. Despite the 42 deg below zero weather, eleven members were present and Pres. J. B. Steele presided. Minutes of the previous meeting were approved and Secy. C. H. Turland read Pres. John Howatt's wire inviting all members to Chicago, as well as other current correspondence.

The following committee appointments were announced:

Membership—R. L. Kent, *Chairman*, H. R. Eade, and E. Fitz Munn.
Technical Programs—D. F Michie, E. Fitz Munn and Frank Thompson.

It was moved by Mr. Michie, seconded by Mr. Eade, and carried that, in order to conform to the Constitution, membership dues of $3.00 be paid for 1936.

President Steele requested the members to observe two minutes of silence in memory of His Majesty, King George V, and later in the evening one minute of silence was observed in tribute to C. D. Kirk, who had been a Member of the A. S. H. V. E. since 1909 and recently passed away.

Mr. Michie then presented a paper for discussion and future action on the subject of Air Conditioning Standards, which was well received and created considerable interest.

Secretary Turland was instructed to obtain copies of the Chicago Air Conditioning Standards for reference.

Michigan

January 15. 1936. The Michigan Chapter of the A. S. H. V. E. was the guest of the Detroit Edison Co. in January and approximately 100 members and guests attended the dinner and the meeting, which followed.

Pres. A. C. Wallich presided and, dispensing with most of the routine business, turned the meeting over to G. D. Winans.

Mr. Winans introduced in order R. M. Van Duser and D. H. Corie, engineers, who discussed recent developments in pipe welding methods used in revamping the Connors Creek Power Station.

After the technical meeting, two motion pictures were shown, and the meeting adjourned at 11:00 p. m., according to the report of G. H. Tuttle.

Minnesota

January 13, 1936. Ninety members and guests of the Minnesota Chapter were present for the regular meeting held at 700 Linden Ave., Minneapolis, and through E. J. Swenson the Minneapolis Gas Company was host for the evening.

The meeting was called to order by Pres. C. E. Gausman and Mr. Swenson introduced the speaker, who was W. E. Stark, Cleveland, Ohio.

Mr. Stark chose for his subject The Gas Industry's Contribution to Air Conditioning and discussed particularly the silica-gel system of dehumidification. He described the advantages of this system as being flexibility and the fact that relatively high temperatures can be used in the refrigeration which supplements the system. Illustrations of equipment suitable for handling a silica-gel system were shown by the speaker.

The Chapter extended hearty thanks to Mr. Stark for coming to Minneapolis and delivering such an interesting and instructive talk, according to the report of Secy. R. E. Backstrom.

Ontario

February 10, 1936. Forty-five members and guests were present at the regular meeting of the Ontario Chapter at the Royal York Hotel, Toronto. Dinner was served at 6:30 p. m.

Secy. H. R. Roth read the minutes of the preceding meeting, which were accepted.

An illustrated talk on Aluminum Foil Insulation was given by Mr. McIntosh and Allyne Rooke spoke on The Manufacture of Tubing.

An interesting discussion followed these two addresses and Pres. M. W. Shears extended a vote of thanks to the speakers on behalf of the Chapter for their instructive talks.

Pacific Northwest

January 22, 1936. Members and guests of the Pacific Northwest Chapter held the regular meeting at the Hungerford Hotel with an attendance of 24. Dinner was served at 6:15 p. m. and the business meeting was opened at 7:30 with Pres. Lincoln Bouillon presiding.

A telegram was read inviting members to attend the 42nd Annual Meeting of the Society in Chicago and S. D. Peterson announced that President Bouillon had been chosen as Chapter delegate.

Secy. D. C. Griffin read a proposed amendment to the Constitution and By-Laws of the Pacific Northwest Chapter.

The meeting was then turned over to W. C. Scott, Jr., who presented six very interesting reels of film on the manufacture of wrought iron plates and pipe.

St. Louis

January 7, 1936. Pres. C. R. Davis called the meeting to order at Garavelli's Restaurant, when 10 members and 6 guests were present. The minutes of the previous meeting were approved as read.

President Davis urged all members to assist in increasing the membership of the Chapter and a number of communications were read by Secy. R. J. Tenkonohy.

The report of the treasurer was given and the following committee appointments were announced by President Davis:

Program—D. J. Fagin, *Chairman,* C. E. Hartwein and H. W. McLarney.

Membership—Paul Sodemann, *Chairman,* J. W. Cooper and G. W. F. Myers.

Entertainment—L. R. Szombathy, *Chairman,* E. E. Carlson and J. G. Barry, Jr.

Educational—G. B. Rodenheiser, *Chairman,* Paul Sodemann and J. M. Foster.

Publicity—F. B. Fillo, *Chairman,* and H. A. Grossmann.

Employment Officer—E. A. White.

Associated Engineering Society—C. R. Davis, *Chairman,* Paul Sodemann, *Alternate;* J. D. Falvey and W. C. B. Sodemann, *Counselors.*

Auditing—L. W. Moon, *Chairman,* R. M. Rosebrough and A. L. Walters.

Mr. Fagin told of plans made by the Program Committee and submitted a written report for the Auditing Committee.

President Davis spoke of matters given consideration by the Board of Governors concerning Chapter dues, date of meeting, and limited chapter membership and it was voted that the action of the Board of Governors be approved.

Secy. H. J. Kipp, of the St. Louis Section of *A. S. R. E.,* was present and extended an invitation to all A. S. H. V. E. Chapter members to attend a meeting of the Section on the subject of Compressor Drives.

There being no further business, President Davis turned the meeting over to Mr. Fagin.

M. M. Easley, St. Louis, was introduced and spoke on the subject of Sound Control and Its Relation to Air Conditioning. With the aid of charts, Mr. Easley developed essential equations showing relations between features of sound, and their application to the installation of air conditioning apparatus, particularly in regard to dampening or isolating objectionable noises. The speaker also covered the subject of the reduction of noise in air ducts by means of insulating a portion of them.

At the conclusion of Mr. Easley's address, 20 min of discussion followed, in which most of those in attendance participated by asking questions, which the speaker graciously answered.

A rising vote of thanks was given to Mr. Easley before President Davis declared the meeting adjourned at 9:50 p. m.

Western New York

February 10, 1936. A dinner meeting of Western New York Chapter was held at the Touraine Hotel, Buffalo, with Pres. W. E. Voisinet presiding and 52 members and guests present.

President Voisinet gave a report on his activities as Chapter delegate to the 42nd Annual Meeting of the Society in Chicago, Ill., and he stressed the growing tendency of the national officers to place more emphasis on the support of Chapter activities and their closer inter-relation.

M. C. Beman, member of the A. S. H. V. E. Council, gave a resumé of Society activities and business.

The report of the Chapter Committee appointed to draw up Comfort Standards for Air Conditioning was read by the secretary of the committee, Ted Messenger, in the absence of Chairman L. A. Harding. It was voted that a copy of the standards be sent to each member of the Chapter for study in advance of discussion at the March meeting. It was also moved and affirmed that all of those present, who were interested in the subject, would be invited to attend the next meeting of the Air Conditioning Committee.

The new Chapter Constitution, which had been approved by the Council, was read by Mr. Beman and it was moved and unanimously affirmed that the Constitution be ratified and a copy be sent to each member.

Particular attention was given to an explanation of the different grades of membership, the status of those who are not Society members but who are invited to attend Chapter meetings, and the new date for the installation of Chapter officers.

January 13, 1936. The January Dinner Meeting of the Western New York Chapter of A. S. H. V. E. was held at the Touraine Hotel at Buffalo, N. Y., with Pres. W. E. Voisinet presiding.

Pres. John Howatt's wire was read, cordially inviting the members to the Annual Meeting and Exposition in Chicago, January 27-31. Vice-Pres. B. C. Candee, in charge of transportation to the meeting, announced relative costs of travel.

It was announced that the progress of the Air Conditioning Standards Committee would be presented at the February 10 Chapter Meeting.

President Voisinet then introduced the speaker of the evening, Dick Harper, whose subject was Motor Applications and New Developments.

Mr. Harper outlined the various types of electric motors, and their particular starting and operating characteristics. He particularly stressed the type motor best adapted for air moving equipment and pumps, mentioning the means of obtaining speed variation. The advantage of gear driven equipment in comparison with flat belt drive was brought out, as were the advantages of synchronous speed motors. Methods of selecting quiet motors were also discussed.

A rising vote of appreciation was accorded Mr. Harper by the 41 members and guests in attendance, according to the report of Secy. J. J. Landers.

Some of the Western New York Chapter members at their February dinner meeting

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 62 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by March 16, 1936, these candidates will be balloted upon by the council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ADAMS, B. C., JR., Student, University of Oklahoma, Norman, Okla.	E. F. Dawson W. H. Carson (*Non-Member*)	Joseph Linton (*Non-Member*) H. V. Beck (*Non-Member*)
ANGERMEYER, A. H., Owner, Angermeyer Plbg. & Htg., Neenah, Wis.	F. G. Weimer A. S. Krenz	Ernest Szekely C. H. Randolph
BACHMAN, FRED, Htg., Vtg. & Plbg. Contractor, Philadelphia, Pa.	F. D. Mensing W. F. Smith	M. F. Blankin W. P. Culbert
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Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

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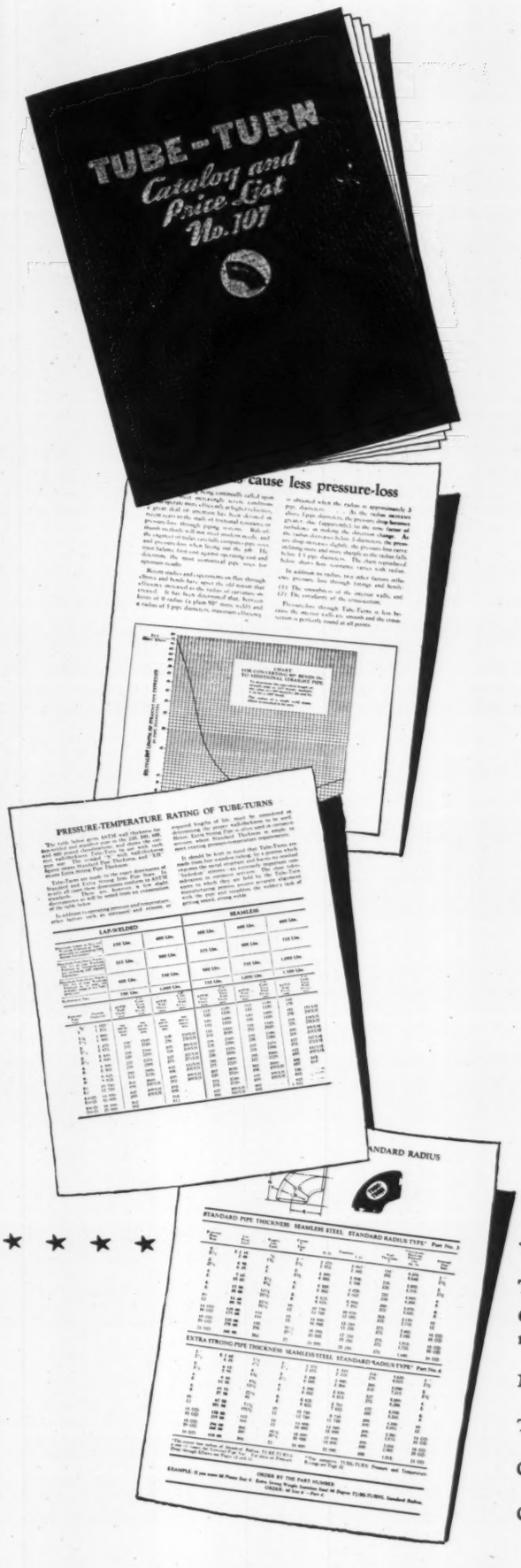

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Purdue Experiment Station Reports on Effect of "Freon" on Fruit in Storage

By **Clarence E. Baker***

FOLLOWING the introduction of "Freon" several years ago as a nontoxic refrigerant for general purpose uses, questions regarding its adaptability to the fruit industry have arisen; many of these questions have concerned themselves with the effect of leaks in the refrigerating system upon the fruit in storage, and tests to determine the effect of the gas upon apples were initiated at Purdue University. The results are described here.

Toxicity to Fruit

Series I. Original treatments made March 21, 1935.

Test No. 1. A glass desiccator with tight fitting cover, equipped with side tubulature, containing about six Golden Delicious apples, six Red Delicious, and six Winesaps was connected directly with a tank of "Freon" by means of rubber tubing, and the air in the container swept out with the gas until it was completely replaced with "Freon." The pinch cocks were then closed at once and the container placed in cold storage at 34 F. No additional "Freon" was supplied.

These apples were observed daily for two weeks and showed no trace of injury at the end of that time, the fruit remaining bright and attractive. The fruit was not further observed until April 16, and on that date the Golden Delicious showed slight scalding, but the Delicious and Winesaps appeared to be as good as at the start. No flavor observations were made as apples confined in an air-tight container are known to behave abnormally through lack of oxygen respiration.

Test No. 2. A second desiccator, similar to the above and containing a similar quantity of fruit, was treated in the same way on March 21, but instead of being placed in cold storage it was left in the laboratory at about 70 F until March 27. At that time the fruit still appeared to be in good condition but had lost its bright attractive color, as would be expected of apples held at this high temperature for several days.

On March 27 this desiccator was again completely swept out with "Freon" and then placed in cold storage. There was little further change in the appearance of the fruit at the end of two weeks from the date of the original treatment. On April 16 the fruit was removed. The Golden Delicious were badly scalded and both the Delicious and the Winesaps were soft and partly broken down, apparently from over maturity.

Whether any of this injury was from the "Freon" it was impossible to determine. This, of course, was extreme treatment and of no practical value but indicates that there is no immediate harmful effect to apples from confinement in an atmosphere of nearly pure "Freon," even at room temperatures.

Test No. 3. A third desiccator was filled on March 21 with the same three varieties of apples and water sprinkled on them. They were then given a short exposure to "Freon," not adding enough to replace all the air. The container was closed at once and placed in cold storage. At the end of two weeks there had been no apparent damage, and on April 16 the fruit in this jar still was in good condition. As late as June 1 the fruit in this container appeared firm, except that the red varieties had faded and a slight scalding was present on the Golden Delicious.

Test No. 4. A fourth desiccator of fruit, treated in a similar manner on March 21, was left in the laboratory until March 27.

*Assistant in Pomology, Purdue University Agricultural Experiment Station, Lafayette, Ind.

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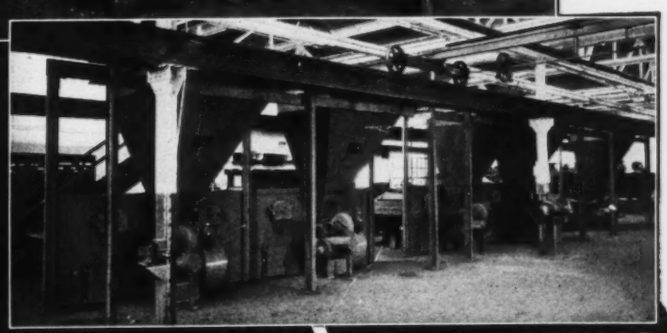

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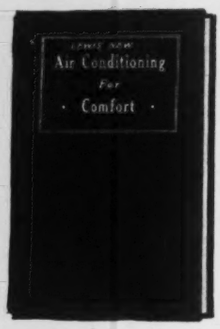

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when it was given a second exposure to a small amount of "Freon" and then placed in cold storage. On March 27 there was no apparent change in the fruit except the loss of attractiveness mentioned in Test No. 2. When removed on April 16 most of the fruit was badly broken down, scalded or over mature.

Test No. 5. A large glass museum jar, holding about one bushel of fruit, was filled with apples of the same three varieties and given a heavy exposure of "Freon" on March 21, by running a rubber tube to the bottom of the jar and supplying "Freon" from a tank until the waves of gas could be seen flowing over the sides of the jar. The cover was replaced and the container left in the laboratory at 70 F and additional charges of "Freon" were given as above on March 22, 23, 25, 26, 27, 28. On April 2 two apples were showing rots, but no damage to the fruit was apparent from the extreme exposures to the refrigerant. From this time (April 2) on, the fruit began to rot and break down, presumably chiefly from the high temperature. Water was sprinkled over this fruit before giving the initial charge of "Freon."

Series II. April 16—June 1, 1935.

Test No. 1. This test involved another trial of a concentrated "Freon" atmosphere in a glass desiccator containing about twelve Delicious and twelve Golden Delicious apples. The air was swept out with "Freon" and the container placed at once in storage at 34-35 F. As a check, another similar container with similar fruit of the same varieties was set up in the same room, but no "Freon" was applied to this container. The lid was sealed in the usual way and was not opened during the period of observation. The weakness of the first series of tests was the fact that no such check was included and it could not be definitely determined whether the ultimate browning of the fruit was caused from the "Freon" or simply was a result of the close confinement of the fruit.

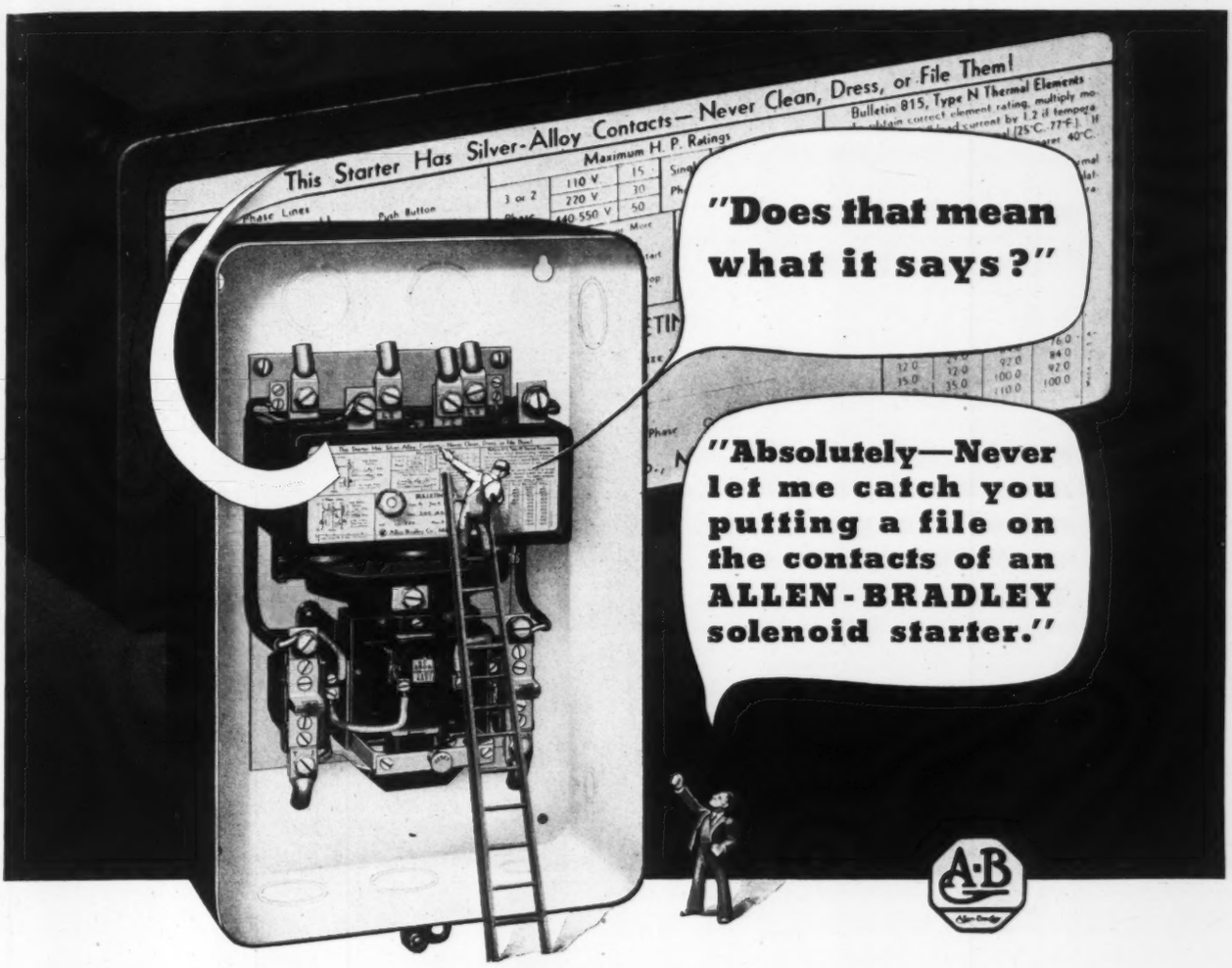
These two lots of apples retained their original appearance until May 10, when a slight brown tinting was apparent on three of the Golden Delicious applies in the "Freon" treated lot, as spots about the size of a dime on the cheek of the fruit. These spots had become only a little more prominent by May 20, but none were yet noticeable on the untreated lot. By May 25, however, similar tinting appeared on several apples in the untreated jar on Golden Delicious. By the end of the observation period, June 1, the tinting or "scalding" of Golden Delicious was common in both lots, but in no case was it more than a faint brown tinting over a considerable proportion of the fruit. The only change noticed in the Red Delicious variety was a gradual dulling of the red color or a fading into a brownish cast. This condition was similar in both lots of fruit.

This test indicates that the "Freon" appears to have had little effect on the discoloring of fruit of the varieties used when held in closed containers without a change of air for an extended period. This test also gives the conclusions of *Series I* more weight, and indicates that the close confinement of the fruit probably was as much responsible for its discoloration as was the "Freon," except, perhaps, in the extreme exposures of *Tests No. 1* and *No. 4* of *Series I.*

Test No. 2. In order to test the effect of "Freon" in the atmosphere of a storage room on more nearly a commercial basis, an unmeasured but considerable quantity of the gas was released directly from a drum of "Freon" into a small experimental cold storage room about 6x8x10 ft at frequent intervals. The drum of "Freon" was left in the storage room and on the following dates the valve of the pressure drum was partially opened for about five seconds and the gas permitted to flow rapidly into the room. The releases of gas were made on April 16, 17, 18, 27, 30, and May 1, 4, 14, 19, and 28.

One basket of Red Delicious, one of Golden Delicious, and one of Winesaps were placed in this room to observe the effects of the gas upon the fruit. Another basket of each variety of apples was placed in a similar room as a check for observation.

When examined on June 1 there was no apparent difference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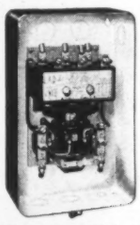


BULLETIN 709

An automatic solenoid starter for squirrel-cage motors. Maximum polyphase rating: 30 hp, 220 v; 50 hp, 440-550 v.

BULLETIN 715

A compact solenoid starter for multi-speed squirrel-cage motors. Max. polyphase rating: 30 hp, 220 v; 50 hp, 440-550 v.

Motor starters are very apt to be neglected by the heating and air-conditioning maintenance man. They may be located in remote and inaccessible corners in a building, next to pumps and fans. Allen-Bradley solenoid starters will operate indefinitely in such spots without attention of any sort. Their silver-alloy contacts do not require filing or dressing. Furthermore, because their life is not filed away, contacts last many times as long as ordinary copper-to-copper contacts. Contact rebound, the greatest cause of contact welding, has been eliminated.

The low drop-out voltage of the Bulletin 709 prevents unnecessary shut-downs when line voltage regulation is poor. Currents of ten times the starter's maximum horsepower rating can be successfully disrupted. All wiring is accessible from the front, and there is plenty of wiring space.

Bulletin 709 starters are available in three sizes, for motors up to 30 hp, 220 v; 50 hp, 440-550 v. Send for the latest literature.

Allen-Bradley Co.
1335 S. First St., Milwaukee, Wis.

ALLEN - BRADLEY SOLENOID STARTERS

between any of the three varieties in the two rooms, and again the presence of "Freon" under the conditions outlined above appeared to have no harmful effect upon the fruit.

Apparently Harmless to Apples

Under the conditions of the tests described, "Freon" appears to be a safe refrigerant for use in the storage of apples from the toxicity standpoint, as its presence in the atmosphere appears to be harmless, except possibly in the case of extreme concentrations. Any inert gas in sufficient concentration to prevent oxygen respiration by the fruit will eventually produce abnormal function or injury.

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 119. Add the new products and companies listed here to your Directory Section which you received in your January 1936 Heating, Piping and Air Conditioning and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Overfeed Stoker, Powdered Coal Burner Combined

No. 663*—A combination overfeed stoker and powdered coal burner, termed the "Pneumatic Spreader," has just been placed on the market. It floats steam size coals—from fine particles to 1½ in. lumps—into the furnace on a stream of air; it is particularly adapted, according to the manufacturer, to the firing of process and power boilers for industrial uses, even burning a low grade of coal which must be burned over a maximum grate area to obtain efficient combustion.

In operation, a feed worm measures the coal and conveys it from the hopper base or bin into a transfer box, where it is picked up by the air stream and carried to spreader nozzles located at proper angles within the firebox to give an even distribution of coal on the grates. Finer particles, which make up a varying proportion of most steam coals, are burned in suspension, with a flame similar to that produced by the powdered coal burner. Larger pieces are burned in the usual manner on the grates, with draft supplied by a secondary low pressure fan. The fuel bed is always shallow, and the temperature at the grate line is below the fusion point of the ash, states the maker; clinkers, therefore, are not formed.

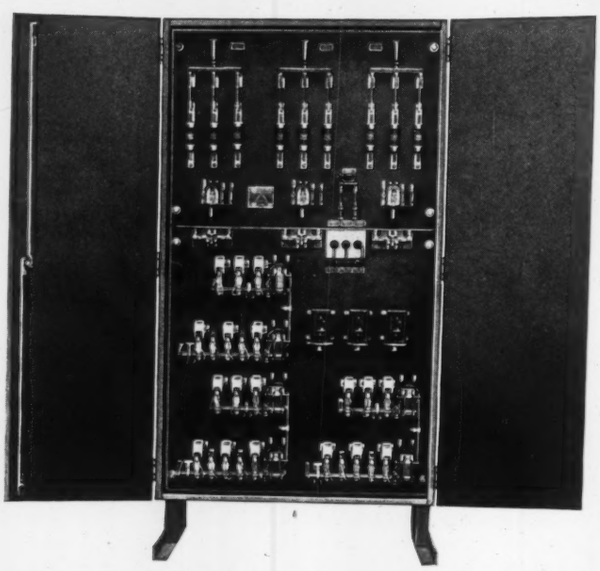
It is not necessary to rebuild the boiler front. The cutting of a hole in the boiler front large enough to admit the spreader nozzle is sufficient. The stoker can be located so as not to compromise the space in the boiler room. It can be placed any reasonable distance, usually from 8 to 15 ft, from the boiler front, or may be in a separate room. There is no overhead machinery to interfere with cleaning operations, and fire doors remain full height. There are no mechanical parts operating in the heat zone.—Iron Fireman Mfg. Co., 3170 W. 106th St., Cleveland, Ohio.

New Bending Brake

No. 664—New "Air Condition Special" sheet metal bending brake is light in weight (265 lb) making it possible for two men to carry it from job to job. Size is 4 ft 1 in. in length; capacity, 20 gauge thickness commercial iron such as used in air conditioning work.

Clark-Sundh

Modernized Automatic Control in keeping with the Modern Air Conditioning Systems. Enclosing Cabinets that are pleasing to the eye and which hold their shape. Doors that you can open and shut continually without trouble. That's what you get if you specify Clark-Sundh Control.



THE CLARK CONTROLLER CO. 1146 E. 152ND ST. CLEVELAND, O.

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at Washington

AEROFIN

FAN SYSTEM HEATING AND COOLING SURFACE

THE nation's capitol city boasts many installations of Aerofin standardized lightweight heating and cooling surface. No finer tribute to the country's premier fan system surface can be paid than to have it keep company with the nation's own capitol.

Aerofin's outstanding record of performance leads inevitably to its choice by leading architects, engineers and contractors. Such experienced professional technicians are exacting in their requirements—and Aerofin never disappoints them. Whether the job is large or small—for heating or cooling or for both, there is an Aerofin unit exactly fitted to your need.

A complete line of equipment for heating and cooling is at your service. The home office in Newark or any of our branch offices will gladly send complete descriptive literature or render prompt personal and efficient technical co-operation. Simply write to the address below.

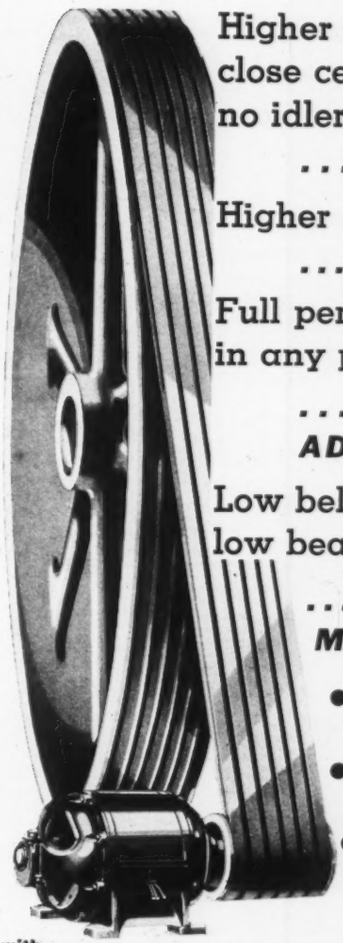
AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus. — List upon Request

AEROFIN CORPORATION
850 Frelinghuysen Avenue
Newark, N.J.
Chicago Detroit New York Philadelphia

WORTHINGTON

MULTI-V-DRIVE

PROVIDES MAXIMUM BELT DRIVE ECONOMY



Higher pulley ratios, close centers with no idlers
... LESS SPACE

Higher speed motors
... LOWER COST

Full performance in any position
... GREATER ADAPTABILITY

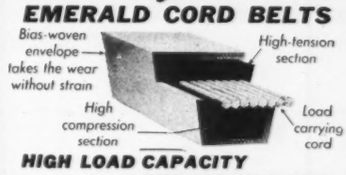
Low belt tension, low bearing loads
... NEGLIGIBLE MAINTENANCE

- CORRECTLY RATED
- EXPERTLY DESIGNED
- ACCURATELY MADE

Fractional up to 1500 horsepower

25,000 STOCK COMBINATIONS ... UNLIMITED SPECIALS

with
GOODYEAR
EMERALD CORD BELTS



HIGH LOAD CAPACITY ... LONG FLEXING LIFE

- ***Send for manual of complete technical data...no obligation***

WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices: HARRISON, NEW JERSEY
A-36272 Offices and Representatives in Principal Cities

Turn-buckle adjustments are used for rapid adjusting for various thickness of material and a graduated scale at the hinge lugs for duplicating work. It is made entirely of steel hinge pins, liberal in size, hardened and ground, and carefully designed to assure accuracy, rigidity, and long wear. The upper jaw is a box-type welded construction. The lower jaw has welded reinforcements with a 1 in. projection for offset work of structural shape. The bending leaf has angle iron welded underneath crotchwise. The three members are provided with truss rods for further adjustments. Available in floor or bench type.—Whitney Metal Tool Co., 110 Forbes St., Rockford, Ill.

Splash Proof Squirrel Cage Motors

No. 665—New line of splash proof, squirrel cage motors just announced is available in all ratings from ½ to 200 hp for constant and multi-speed, continuous or intermittent duty in all voltages and cycles, for any torque and starting current.

The construction provides protection to the inner parts from splash or spray. Ventilation is permitted by small openings in the bottom of the end brackets for the air intake and louvers in the frame cover underneath the motor for the air exit.—The Imperial Electric Co., 64 Ira Ave., Akron, Ohio.

Magnetic Valve Serves Many Purposes

No. 666—New "K-10" magnetic valve, originally designed to control viscous fluids at high pressures, employs a unique lever action which develops high seating pressure to insure a tight shut-off. The lever action also facilitates opening the valve at high pressures.

It is applicable to both high and low pressures for the control of water, gas, air, refrigerants, oils as heavy as No. 6, or steam. Connections are brazed to withstand steam temperatures. Operation is satisfactory on pressures up to 300 lb on small port openings and comparable pressures on the larger port openings, states the maker.

The valve, packless in construction, consumes 14 watts of energy. Internal parts are of brass and stainless steel to prevent corrosion, and external parts are rust-proofed. Terminal box revolves in any direction to facilitate wiring. Listed as standard by Underwriters' Laboratories.—General Controls Co., 1370 Harrison St., San Francisco, Calif., and 1505 Broadway, Cleveland, Ohio.

New Underground Pipe Line Insulation

No. 667—A new insulation, known as "Adsco Cell-Concrete," for underground steam and hot water pipe lines, possessing low heat conductivity, and the ability to retain its physical strength and shape as well as to regain its insulating value after repeated submergence in water, was recently made available. It is made entirely from portland cement mixed with a foam, producing a light weight cellular concrete of a specific gravity of approximately 0.3. It can be mixed on the job and poured around one or more pipes in conduits of various constructions. It has been used in Europe for over 10 years to insulate underground steam and hot water pipe lines.—American District Steam Co., North Tonawanda, N. Y.

Rubber Pipe Joint for Industrial Waste Lines

No. 668—The "Flexlock" joint is now available for use with specially constructed ceramic pipe in low pressure service—a maximum of 15 lb per sq in.—and in temperatures not exceeding 175 F. It offers a permanent, positive seal for bell-and-spigot pipe conveying acids, alkalies, sewage and other industrial wastes, according to the maker. Its adaptation to ceramic pipe was developed in cooperation with the Robinson Clay Products Co. and U. S. Stoneware Co.

This joint is a rubber ring or gasket having internal and

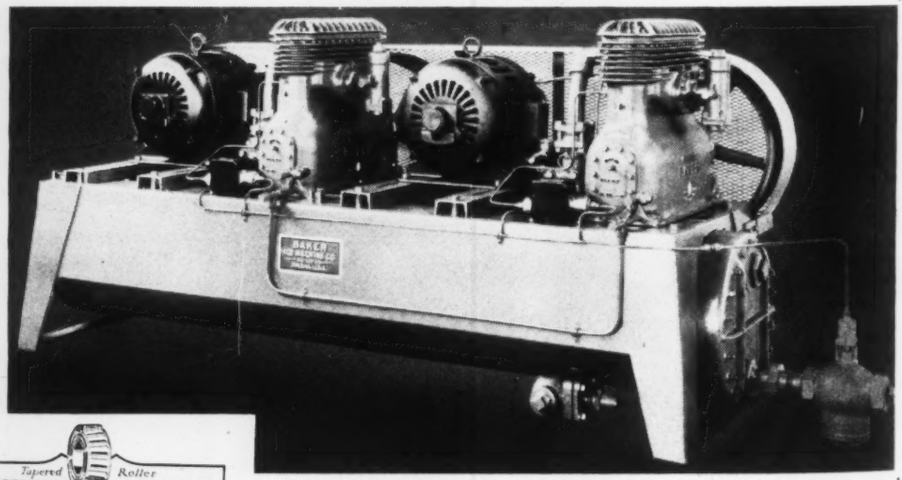
The Year's Foremost Achievement

THE BAKER DUAL UNIT

WITH AUTOMATIC CAPACITY CONTROL

For Air Conditioning and Comfort Cooling Applications

Especially designed by Baker to handle the variable load requirements of Spring, Summer, and Fall weather. Write for full specifications.



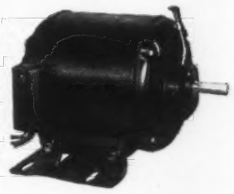
MEMBER AIR CONDITIONING MANUFACTURERS ASSOCIATION INC. RELIABILITY ACMA EXPERIENCE SOLUTIONS

This emblem assures you prompt, reliable factory co-operation on all air conditioning jobs!

Tapered Roller TIMKEN BEARING EQUIPPED

Baker Ice Machine Co., Inc., 1509 Evans St., Omaha, Nebraska
Sales and Service Offices in Every Large City

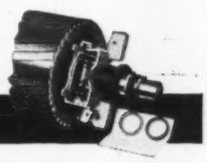
HERE'S WHY WAGNER MOTORS ARE QUIET



1 ● **Rotor** is dynamically balanced to eliminate vibration and noise arising therefrom. The number and the dimensions of rotor slots are carefully chosen to minimize magnetic noise.

DYNAMICALLY BALANCED ROTORS

2 ● **Cork Thrust Washers** located at both ends of the motor cushion the free-end movement of the rotor thereby preventing noise.

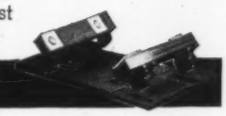


CORK THRUST WASHERS

3 ● **Steel-backed Babbitt-lined Bearings** are diamond-bored to secure bearing clearances small enough to avoid any possibility of excessive play and at the same time have ample clearance to afford a liberal oil film between shaft and bearing.

DIAMOND-BORED BEARINGS

4 ● **Resilient Mounting**, interposed between motor frame and base, is made up of layers of rubber and steel vulcanized together — is elastic enough to absorb the small amount of vibration remaining in the most carefully-designed motor.



RESILIENT MOUNTING

There are many other features of Wagner small motors, contributing not only toward quiet operation, but toward such essentials as dependability, performance, simplicity, and appearance. These features are fully described in Wagner Small Motor Bulletin 177, which will be sent upon request.

Wagner Electric Corporation MS336-2L

6400 Plymouth Avenue Saint Louis, U.S.A.

Motors **Transformers** **Fans** **Brakes**

Phoenix Building, Duluth, Minn.

HEATING COST REDUCED AFTER MODERNIZATION

Webster Moderator System Helps Phoenix Building, Duluth, To Check Heating Faults

SERVES SEVEN RETAIL STORES

Duluth, Minn.—Heating modernization helped the Phoenix Building, in downtown Duluth, to reduce its heating steam consumption from 359 to 206 lbs. of steam per degree day.

Installation of the Webster Moderator System together with new concealed Webster System Radiators was completed during the 1933-34 heating season as an important part of a thoroughgoing program of property modernization.

In a typical month before modernization, the Phoenix Building required 559,800 lbs. of steam. With the Webster Moderator System, after correction for degree day differences, the building saved 194,000 lbs. of steam—a cash reduction of $172 for a single month.

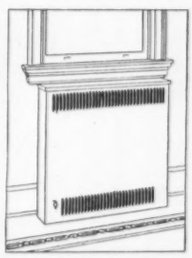
The heating modernization program is not solely responsible for these savings, but the owners credit the Webster Moderator System with a "very considerable portion of the reduction." Other factors include the lowering and insulation of ceilings on the second floor and a slight reduction in floor area.

In addition to the remarkable fuel savings, heating service is greatly improved. The new system is able to meet every heating need of a variety of tenants, by careful control of steam circulation.

Outdoor Thermostat which provides "Control-by-the-Weather."

Regardless of the severity of the weather, the entire building heats evenly and rapidly. The warm-up period has been considerably shortened.

"The Webster System has given us everything that we expected of it and more too," says H. L. George, representing the Massachusetts Real Estate Co., owners of the building. "There is absolutely no comparison in tenant satisfaction."



Webster System Radiation included in the Phoenix Building modernization provides balanced heating service... No cold corner rooms ...Harmonizes with decorative scheme. For modernizing interiors or for new buildings. Send for booklet "Webster System Radiation."

●

If you are interested in (1) improved heating service and (2) lower heating cost in your building, address

Warren Webster & Company . . . Camden, N. J.

Pioneers of the Vacuum System of Steam Heating

Branches in 60 principal U. S. Cities . . . Darling Bros., Ltd., Montreal, Canada

external circumferential ribs which grip the bell and spigot of the pipe. While the gasket permits easy insertion of the spigot, the shape of the corrugations combined with the resilience of the rubber, forms a multiple seal which resists tendency of the pipe sections to pull apart, the effect of pressure being to make the joint tighter. Installation is said to be simple and can be handled by ordinary workmen.

The gasket is offered in two types for use with vitrified sewer pipe and chemical stoneware pipe. Both types of pipe are available in a range of sizes up to 36 in.—The B. F. Goodrich Co., Mechanical Goods Division, Akron, Ohio.

Full Line of Room Thermostats

No. 669—One feature of an improved line of room thermostats is concealed contacts to provide full protection from dust. Also, the units are now made with a dead front with no live parts exposed in the thermostats.

Thermostats for 250 volt service as well as for 125 and low voltage (30 and less) are available in this line. There are three types; standard, heat accelerator, and an outside compensated cooling control unit. In addition to the regular wall mounting, the instruments may be had with mounting accessories for special outlet box, conduit connection wall plate for over-the-surface mounting and standard switch box with plain or switch plate. This switch plate is a transfer switch for changing the thermostat from winter heating to summer cooling control or the reverse. Provisions have been made for knockouts at the top and bottom of the underside of the thermostat base for over-the-surface wiring connections. Five finishes are available—gold, chrome finish, brown lacquer, walnut, bakelite, and ivory plaskon.—Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.

Respirator for Lead Dusts

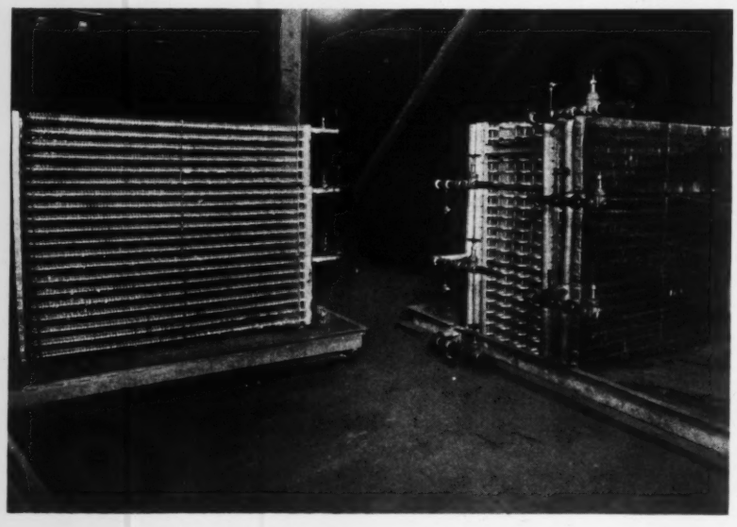
No. 670—A respirator for lead and Type A dusts recently offered has a filter bag through which breathing very close to normal is assured because of the large filtering area of 40 sq in., states the manufacturer. The face mask is made of rubber and is adjustable to any shape of face by bending a wire forming spring which constitutes a part of the lower mask edge.

The filter bag is assembled on the mask by means of a screw ring inside of which is the intake valve assembly including moisture baffle, serrations to prevent air lock and a flexible intake diaphragm. Air is drawn in through the filter bag at the front and exhausted through the valve assembly below the face mask. The complete respirator weighs 5¼ oz.—Willson Products, Inc., Reading, Pa.

Economizer Cuts Water Consumption of Air Conditioning Systems

No. 671—Displayed for the first time at the recent International Heating and Ventilating Exposition, a new "Economizer" is designed to reduce the water consumption of air conditioning systems by about 99 per cent, depending on operating conditions, says the manufacturer. It is a combination forced draft cooling tower and refrigerant condenser, arranged either for indoor or outdoor installation; when used indoors ducts bring in outside air and exhaust the heated, humidified air to the atmosphere.

A fan passes the outside air through a bank of bare pipe coils over which water trickles in a direction opposite to the air flow, to give a baudelot cooling action. Refrigerant is condensed inside the coils, and flows by gravity to the liquid receiver built in the base. The cooling water is recirculated from the drain pan by a pump driven by a small fractional horsepower motor.



BUSH COILS

installed with a brine system in a modern brewery. These coils have a 3¼" square fin spaced ¾" apart on 1" O. D. steel tube and are galvanized. However, there are 36 other standard combinations of fin and tube sizes and fin spacings available to meet all requirements and they can be made in all standard metals.

THE BUSH MFG. CO.
HARTFORD CONN.

NEW YORK
489 FIFTH AVE.

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CHICAGO
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for "FREON"

VILTER COMPRESSORS

Air conditioning, in its application to modern industrial and commercial needs, acquires a new and greater acceptance through the introduction of the new Vilter "Freon" Compressor.

It introduces features that are revolutionary in their design and function, the result of three years' development by one of the industry's outstanding compressor builders.

Its compact size and proportions make it ideal for larger installations where floor space and head room are a factor.

For economy of operation and protection of investment, investigate the Vilter "Freon" Compressor.

THE VILTER MANUFACTURING COMPANY
"SINCE 1867"
2148 South First Street
MILWAUKEE, WISCONSIN
REPRESENTATIVES IN PRINCIPAL CITIES

3/32 OF AN INCH THAT ADDED FLEXIBILITY OF TRIMO

New TRIMO ALLOY PIPE WRENCH

GIVES YOU A QUICKER BITE —— A QUICKER RELEASE

• TRIMO has one feature that sets it apart from other wrenches. Its swinging frames give it 3/32 of an inch added flexibility—and that means jaws which unlock as well as grip—a wrench that swings back to its original position when you tell it to—a wrench that can let go as well as take hold.

Try TRIMO—the wrench made throughout of Chrome Molybdenum Nickel Alloy Steel—with handle drop forged—not cast.

For any type of work, TRIMO is the safest, most economical pipe wrench known.

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON), MASS.

TRIMO

The continuous evaporation of water pumped over the coils is replenished automatically by a float valve. This make-up water amounts to about one per cent of the water required by an air conditioning system.

Features are low pumping cost, galvanized welded steel coils, low fan power requirements attained because eliminators are unnecessary, and cleanability of coils through easy removal of both front and back panels. The liquid receiver is made of seamless steel with a dished head, and is provided with a vortex eliminator to insure a minimum liquid level and maintain a liquid seal on the line.

Available in a number of standard factory-built models, capacities ranging from 3 to 50 tons of refrigeration. Larger sizes are assembled to order in the field.—York Ice Machinery Corp., Roosevelt Ave., York, Pa.

New Design for Air Compressor Valves

No. 672—A new development in valve design for air and gas compressors is the "channel" valve, recently announced. With this valve, a greater-than-usual portion of the valve opening is utilized, which tends toward slower air speeds through the valve ports.

Only moving parts are a number of valve channels, within each of which is a flat spring. The spring fits snugly within the channels so that when the valves lift, the springs straighten and a small quantity of air is trapped between springs and channels. Thus air cushions are formed whose function it is to decelerate the valve channels after opening and bring them to a stop softly and quietly, without impact. This makes a quiet valve, and the total elimination of impact means that one of the conditions usually most destructive to compressor valves is obviated, states the maker. Valve channels consequently can be made light in weight, their channel form being relied upon for strength and rigidity. They lift straight off the seat without flexing, returning to the same position. Springs can be designed solely as springs because they are not called upon to act as valves.

To introduce the valve, a unique bulletin has been issued which clearly shows the assembly through the use of transparent pages —Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Small Size Inert Gas Producer

No. 673—During the chemical industry exposition recently held in New York a new small size inert gas unit with a capacity of 1000 cu ft per hr was introduced. Overall dimensions are 60 in. long by 32 in. wide by 43 in. high. Weight is about 1500 lb.

The mechanism consists of a blower and gas pump, handling air and gas respectively. These elements are delivered separately to a water-cooled combustion chamber where the gas burns and produces the inert mixture. This is discharged through a cooler to reduce the temperature to the desired point. The drive unit can be either electric motor or gas engine.

Inert gas, containing either zero oxygen or zero carbon monoxide, when using gas or oil for fuel, can be economically produced in large volumes. During recent years, the use of an inert gas has come to the fore, and provides actual savings in plant operation, as well as eliminating hazardous procedures encountered in process industries. Purging explosive mixtures from plant equipment is one function. Inert gas producers are available in a range of sizes up to 60,000 cfh, both portable and stationary types.—Roots-Connersville Blower Corp., 16th St. and Columbia Ave., Connersville, Ind.

Rotary Air Compressors Have Unique Features

No. 674—A new line of two stage sliding vane rotary air compressors for pressures up to 100 lb gage incorporates unique fea-

FOR MAXIMUM EFFICIENCY . . . INSULATE

Air-Conditioning pipe lines with

NOVOID CORK COVERING

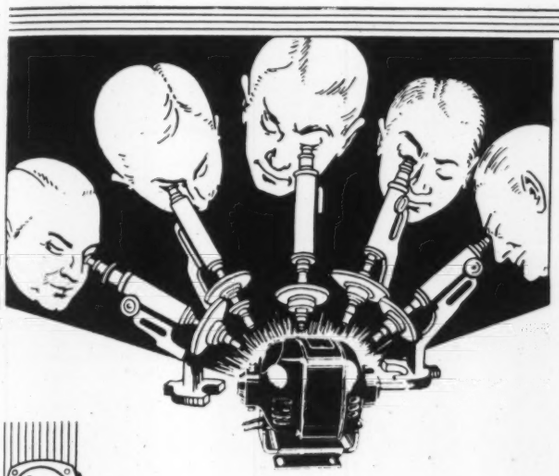
DEPENDABLE, economical service is assured when air-conditioning pipe lines are guarded with Novoid Cork Covering. Thanks to cork's natural cell structure, this efficient insulator definitely bars the passage of heat, maintaining uniform temperatures. It offers long years of satisfactory, low cost performance.

Novoid Cork Covering is available in sectional covering for cold water risers; also, covers for welding ells (standard or long radius) of 90° or 45° are delivered ready to fit pipe sizes up to twenty inches inclusive. Novoid Cork Lagging is furnished for covering tanks. For complete information, write us or consult our nearest distributor. No obligation.

CORK IMPORT CORPORATION
330 WEST 42ND STREET NEW YORK CITY

AUTHORIZED DISTRIBUTORS OF CORK COVERING

Name	City	State
The Carey Company	Cleveland	Ohio
	Detroit	Michigan
Dade Refrigerating Co., Inc.	Miami	Florida
Henry V. Dick & Co.	Charlotte	North Carolina
E. J. Eddy, Inc.	Buffalo	New York
	Rochester	New York
The Geo. L. Freeman Co.	Toledo	Ohio
Hamilton Company, Inc.	St. Louis	Missouri
	Memphis & Nashville	Tennessee
	Kansas City	Missouri
	Dallas	Texas
Johnson Asbestos Co.	Springfield	Massachusetts
Robert A. Keasbey Co.	New York City & Syracuse	New York
Laird Engineering Co.	Charleston	West Virginia
Lewers & Cooke, Ltd.	Honolulu	Hawaii
G. A. MacArthur Co.	St. Paul	Minnesota
W. A. Owen	Johnson City	Tennessee
Rhode Island Covering Company	Providence	Rhode Island
Schooley & Company	Wilkes-Barre	Pennsylvania
Sprinkmann Sons Corp.	Milwaukee	Wisconsin
	Chicago	Illinois
	Peoria	Illinois
P. S. Thorsen Company of Mass.	Boston	Massachusetts
Tropical Refrigerating Co.	Tampa	Florida
Virginia Ice Machine Corp.	Richmond	Virginia
Wallace & Gale Co.	Baltimore	Maryland
Warren & Bailey Co.	Los Angeles	California
	San Francisco	California



1/8 1/6 1/4 1/3 1/2 3/4 1 1½ 2 3

STUDY WITH CARE BEFORE YOU DECIDE

Builders of stokers and oil burners who specify Leland motors will each find motor satisfaction in their respective choices. And the same thing applies to those who build domestic water systems, washing machines, ironers, refrigerators, etc. In each and every case — there is a Leland motor especially designed for the application.

They will also find the Leland service organization of more than one hundred stations fully equipped to render prompt and efficient service.

Condenser-start induction-run
Repulsion-start induction-run
Polyphase Direct Current

Other standard designs available.
Special designs where required.
Cradle, rigid flange, foot or lug mountings all available.
Frames interchangeable.

Contact nearest representative or write

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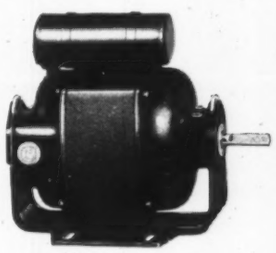

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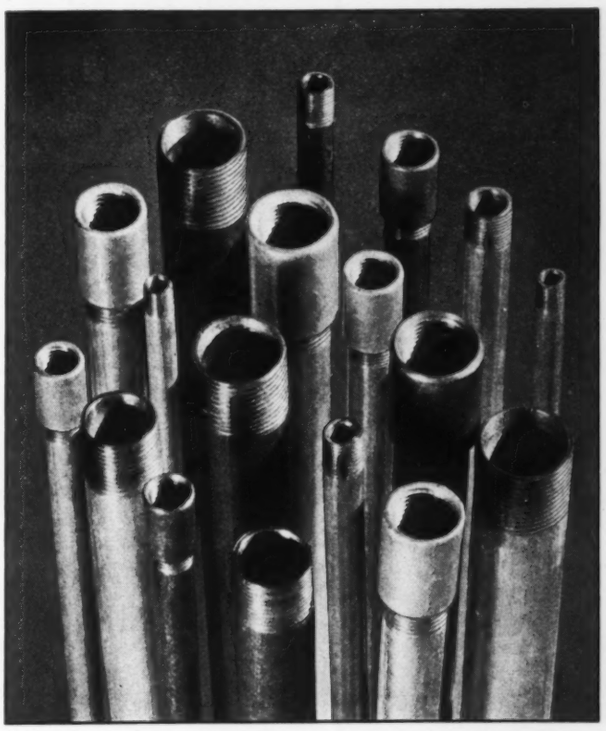
THE LELAND ELECTRIC CO.
DAYTON · OHIO · · · U·S·A

Leland Motors

THERE'S A VAST DIFFERENCE IN STEEL PIPE



. . . AND THIS IS THE REASON

When you think of Fretz-Moon Pipe, don't consider it as ordinary steel pipe. It is made of a different type of material and by an exclusive manufacturing process —both of which combine to produce pipe possessing a high degree of uniformity, ductility and cleanliness not found in steel pipe made by ordinary methods.

The material—steel of evenly high quality, specially rolled into skelp and formed into coils containing as much as 1200 feet in a single length.

The process—an exclusive method of manufacture known as the "continuous process" from which modern scientific instruments and engineering have eliminated all guesswork, all chance. Every inch of pipe made by this process is the same in quality as every other inch. Never under- or over-heated. Always mechanically perfect.

If you would like to know more about the difference in steel pipe, write for the complete story of the "continuous process." It will be sent you in illustrated booklet form.

FRETZ-MOON TUBE CO., INC.
BUTLER • PENNA.

FRETZ-MOON PIPE
BLACK AND GALVANIZED

tures of design; both stages as well as the intercooler, are contained in a single casing. This type of compressor is designated the "Ro-Twin"; it offers the advantages of reduced length and floor space, less weight, only one stuffing box and one coupling, no external air piping between stages to keep tight and a simple lubrication system, states the maker. Having only two bearings, and one flexible coupling, alignment is easily maintained. The air delivery is free from pulsations and the operation is said to be smooth, quiet and vibrationless.

A complete line of "Ro-Twins" has been developed, from 20 hp, 1740 rpm to 100 hp, 690 rpm, for actual air deliveries from 69 cfm to 412 cfm at 100 lb gage pressure.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Powdered Coal Heating Plant

No. 675**—A fully automatic heating plant for apartment buildings and homes which uses powdered coal, was shown for the first time at the recent Heating and Ventilating Exposition at Chicago. The unit has been developed by Aubrey J. Grindle, pulverized coal expert.

The standard unit has a storage capacity of 5,000 lb of pulverized coal. The fuel is delivered from a tank type truck to a hopper, which is part of the unit. Delivery is made through a hose to eliminate dirt and dust. The ash, which collects in small quantities, is removed by a similar hose.

From the hopper, the fuel is carried by a specially designed feeder, which has a toothed wheel, to a tube where a vacuum draws it to the inlet of an exhaust fan. The fan conveys the powdered coal up a flexible hose to the burner nozzle. The fuel enters the combustion chamber downward. Proper aeration is provided in the nozzle to insure correct combustion. The coal burns in suspension.

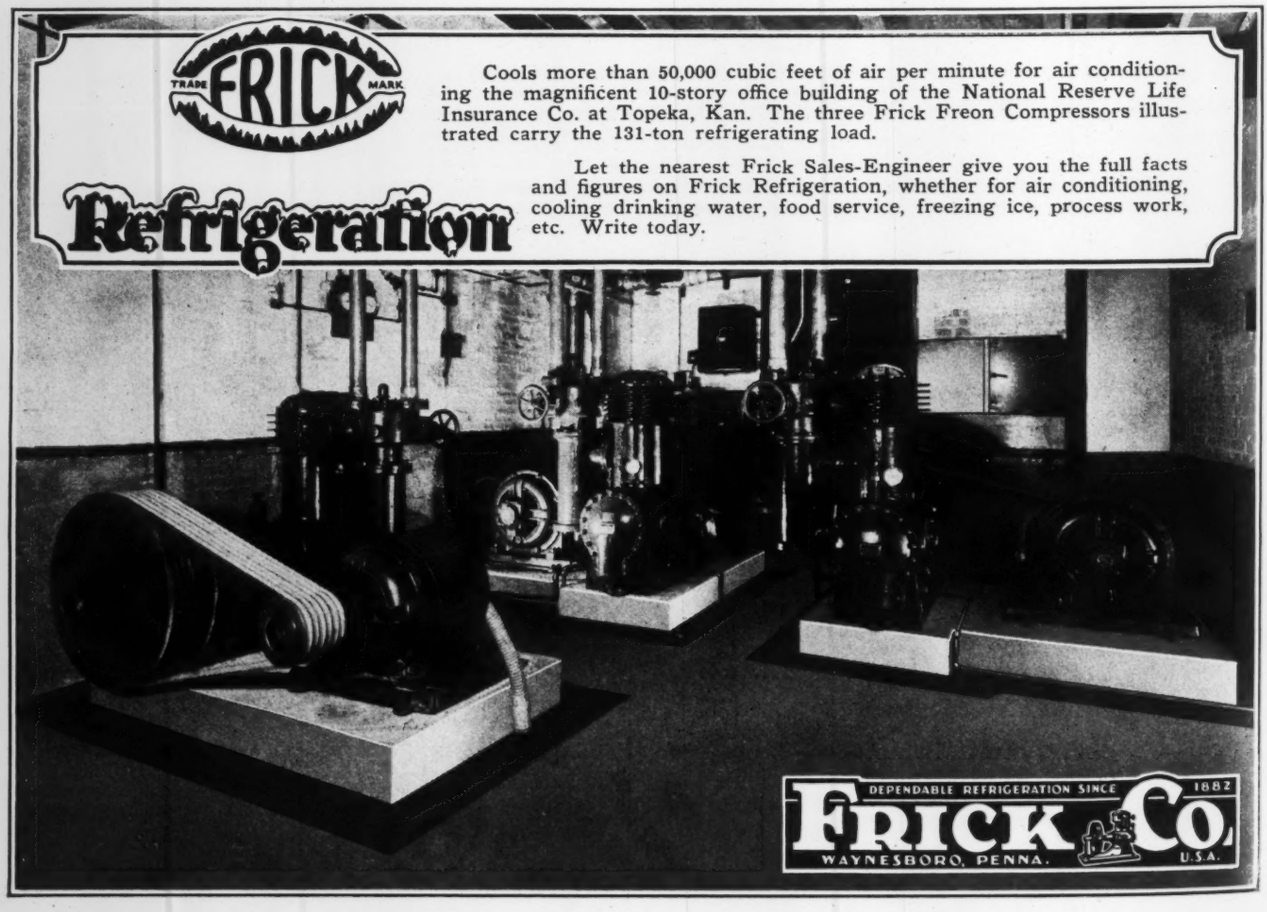
The plant is controlled by a thermostat. When the temperature drops a degree below the desired point, a special alloy steel wire at the top of the unit starts to heat. A few seconds later gas is automatically turned on in a small nozzle. The wire lights the gas. Then the coal feeder starts. The gas ignites the coal. As the firing chamber heats, both the wire and the gas automatically shut off. In the event the fuel fails to ignite, a safety device operates.

Operation of the unit is quiet, and the fact that the unit is completely dead when not in operation, eliminating a pilot light, is a factor in cutting costs, states the manufacturer. For domestic hot water, a special tank is installed inside the unit.—The Gaskoal Corp., 120 S. LaSalle St., Chicago, Ill.

Silent Switch with No Moving Parts

No. 676—A small, compact electric switch, completely silent in operation and with no moving parts to wear out, was announced as a new development on the occasion of the recent opening in Rockefeller Center of the New York Museum of Science and Industry. About the size of a marble, the new switch utilizes the mercury break principle to function without a click.

The switch consists of two shallow chrome-steel cups about ¾ in. in diameter, sealed together with a strip of lead glass to form a hollow compartment. Separating the cups is a disk of ceramic material in which there is a small hole located near the edge. The compartment is evacuated after fabrication and in it about four grams of mercury are inserted. The mercury fills, roughly, one-quarter of the space. After insertion of the mercury, the compartment is filled with hydrogen at about atmospheric pressure and sealed off by welding. In the off position, the hole in the ceramic insulating disk is above the line of the enclosed mercury. However, when rotated 20 deg the switch assumes a posi-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Cools more than 50,000 cubic feet of air per minute for air conditioning the magnificent 10-story office building of the National Reserve Life Insurance Co. at Topeka, Kan. The three Frick Freon Compressors illustrated carry the 131-ton refrigerating load.
Let the nearest Frick Sales-Engineer give you the full facts and figures on Frick Refrigeration, whether for air conditioning, cooling drinking water, food service, freezing ice, process work, etc. Write today.
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FRICK CO.
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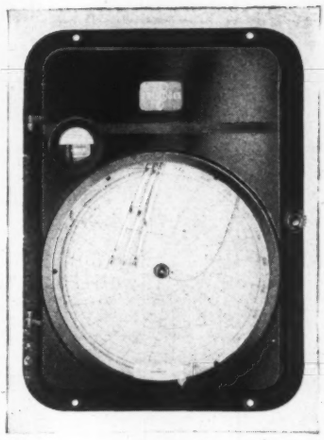

Meters flow *precisely*

in severe field service

Employing the widely accepted orifice and mercury manometer system of flow measurement, this Bristol's meets the needs of industry for a rugged, accurate and reasonably-priced mechanical flow meter. Even under severe field conditions it can be counted on to give precision measurement.

Meter body is of forged steel, with stainless steel parts inside mercury chambers. Connections are welded or mechanical. The stuffing box is of hardened stainless steel. Grease-packed, it is absolutely leak-tight.

Check valves, operating by gravity, prevent the loss of mercury. A bushing, inserted in the line between the two chambers, dampens the effects of pulsations. Meters for working pressures of 1000 lbs. are tested at 2000 lbs. Special bodies tested at 5000 lbs. are available for working pressures up to 3000 lbs. Write for Bulletin 425.

Illustration above shows Bristol's Recording Flow Meter Model 1160 MF

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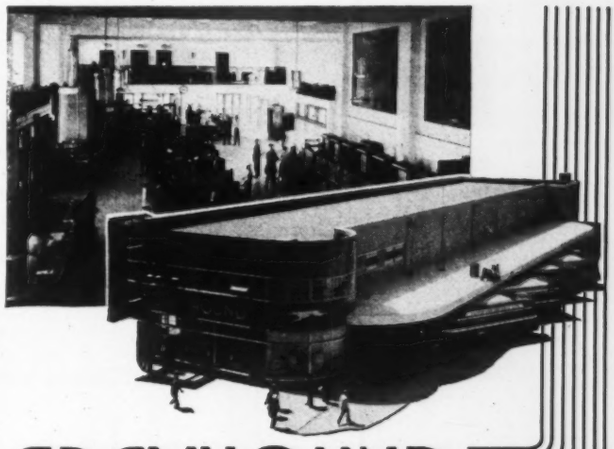

GREYHOUND LINES

Install SARCO HEATING SYSTEMS

As modern as the sleek busses, familiar on every highway, are the terminal facilities provided by the progressive Greyhound Lines.

Our pictures show the handsome New York terminal of the Eastern Greyhound Lines at 34th Street and Eighth Avenue.

A complete Sarco Heating System of the latest type was selected by Thos. W. Lamb, architect, and installed by James H. Martin, New York heating contractor.

Sarco was also chosen for a large Greyhound Service Garage at Long Island City, and the new terminal in Washington, D. C.

Sarco leadership is no accident. It is the result of twenty-five years' experience in the production of quality specialties for steam heating systems.

Use Sarco with confidence. Catalog O-45 tells the story. May we send your copy?

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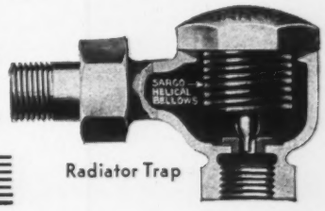


Radiator Trap

tion where the mercury can flow through the hole, thus establishing a contact between the two chrome-steel cups and closing the circuit.

Hydrogen is used in the switch because of its properties as a cooling agent and because in it an arc can be better quenched.

An additional feature of the switch is a tiny plate of steel with 0.2 of a mil of platinum superimposed on its surface. One such plate is welded to the inside of each steel cup, affording better mercury to metal contact and keeping the switch from heating. As a final operation in its manufacture, the switch is cadmium plated to give a good surface for external contact. It is then ready to be fitted into a suitable enclosing case or to be incorporated into any switching operation.—General Electric Co., 1 River Rd., Schenectady, N. Y.

Separable Well Tube System for Temperature Controllers

No. 677—A separable well is required on many temperature measurement and control applications to protect the temperature sensitive bulb from corrosion or erosion, to give it adequate support, or to permit the removal of the bulb at any time without interrupting the processing. To eliminate delay or lag in transmitting a change in temperature to the bulb due to the extra thickness of metal and the dead air space between the well and the bulb, a separable well tube system, known as the "Thermospeed," has been developed. According to the maker, the response due to this new construction is approximately six times faster than the average separable well tube system now in service, and almost twice as fast as separable well thermocouples.

The manufacturer looks upon the "Thermospeed" construction as a most important advancement in tube system design; it means that a dial or recording thermometer so equipped will be extremely accurate in indicating every temperature variation and as it assures closer regulation from controllers because the corrective action of the controller occurs at the slightest tendency of a departure from the control point.—Taylor Instrument Companies, 95 Ames St., Rochester, N. Y.

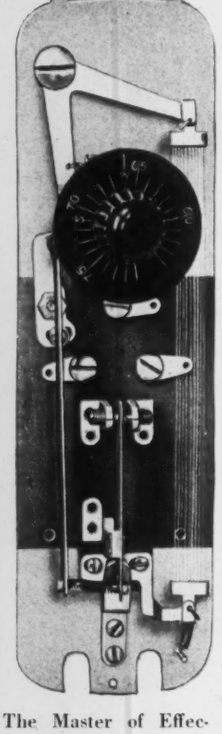
Packless Solenoid Valve for Various Services

No. 678—Packless type of solenoid valve for control of air, gas, fuel oil, water, methyl chloride, "Freon," etc., is designed to permit dis-assembling without removing from pipe line. Body is all bronze, screwed, with self aligning bronze needle type disks closing in the direction of flow. The removable bonnet carrying the solenoid has a single gasketed joint of improved design to obviate danger of leakage in refrigerant service. The line includes two pipe sizes—⅜ and ½ in.—, three port sizes, and various electrical specifications.—Automatic Switch Co., 154 Grand St., New York, N. Y.

Air Circulators and Exhaust Fans

No. 679—24 in., four blade, two speed air circulators recently announced have a wide field of application; they can be used in all commercial, industrial and public buildings. Motor is of the induction type, totally enclosed, and blades are of chromium plated steel. Motor, guard, and mounting ring are finished in lustrous baked black enamel. They are furnished complete for ceiling mounting—also available with wall bracket, counter column or adjustable floor column mountings.

Also announced by the same manufacturer are exhaust fans in 16, 18, 24 and 30 in. sizes which are the multi-blade type. Motors are of such size to provide power for exhausting against ordinary pressure heads. They have two speeds of operation, and are furnished complete with steel mounting rings.—Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.



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COMFORT or COOLING?

You cannot deliver Comfort unless your Cooling system be regulated to the **conditions of humidity** that are ever changing. Monday may be very dry, Tuesday may be moist, and each has its peaks of occupancy.

The Friez Comfortrol will make the humidity work for you.

It is a Thermostat-equipped with a humidity sensitive element-reacting to modulate the cooling needed to suit the varying humidities. The Comfortrol will fit in the place of any Thermostat and **will valuably improve any Air-Conditioner.**

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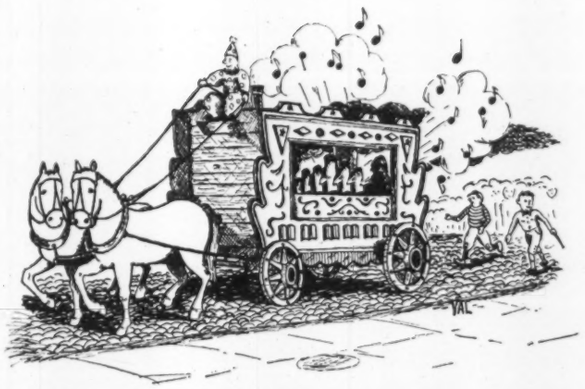

STEAM
Makes Sweet Music on a Calliope—

BUT what kind of a noise does it make on your underground pipe lines? The best sound it can make *there* is silence. If it hisses, you won't hear it. But it's hissing away your money, rotting your insulation, running up your fuel bills.

Keep your underground steam power or heating lines (present or future) tight, dry, efficient with a Ric-wiL System. Made in a variety of types, materials, and insulation methods (including the famous waterproof asbestos Ric-wiL Dry-paC), it secures satisfactory and economical results on *any* problem of underground steam transmission. Ric-wiL Systems are complete, including installation instructions and engineering service drawings, also supervision for the job if desired. Write for Bulletin.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
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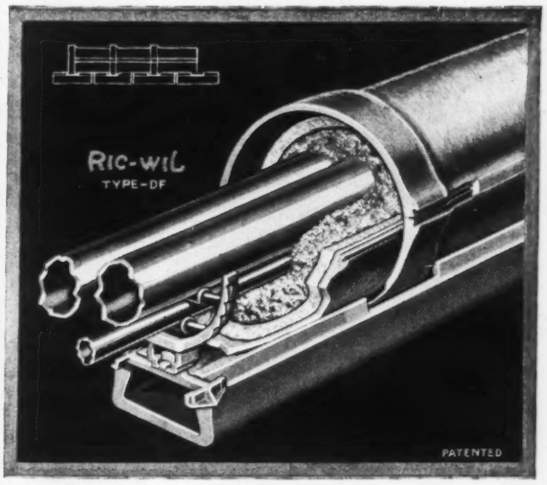
• Ric-wiL Dry-paC is pure asbestos insulation, which has certified conductivity of only .36 B. T. U. for low pressure.



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CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Photo: H. Armstrong Roberts

Positively Controlled Direction

Just as the switchman, by a turn of the switch, directs a car or train in any desired direction, so the air conditioning engineer of today can direct air flows equally positively and with certainty.

Engineers recognize that Independent "Fabrikated" Adjustable Directed Air Flow Registers and Grilles are a necessity in today's air conditioning installations. Each grille bar can be set at any angle up to 45 degrees, before or after installing. These new adjustable forced air registers and grilles are solving many problems in air conditioning to the delight of both engineers and owners.

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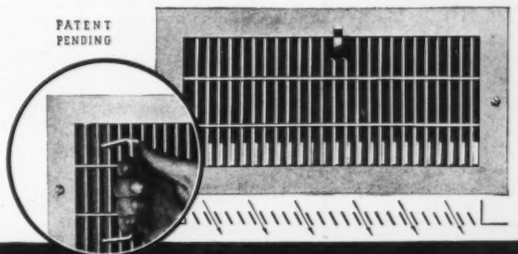

INDEPENDENT

"Fabrikated" adjustable

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DIRECTED AIR FLOW REGISTERS and GRILLES

New Pressure Switches

No. 680—New "Klixon Type PS" pressure switch for steam heating boilers and industrial applications is a snap-acting device adjustable both as to cut-in setting and differential. Motion resulting from pressure exerted on the bellows is transmitted directly to the disk actuating the contacts. Bellows, disk, and contacts are enclosed and protected. Adjustments for cut-in and differential pressures are independent and are enclosed to prevent accidental change or tampering, accessible through removal of cover which is secured by two screws. No current carrying parts are exposed.

Eight 2- and 3-wire models for electrical ratings from 0.3 to 10 amperes are available.—Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.

Evaporative Condensers for Air Conditioning, Refrigerating

No. 681—Evaporative condenser—developed to enable cutting water costs on air conditioning and commercial refrigerating plants by as much as 90 per cent, reduce pumping charges, and save space—utilizes recirculated water spray which absorbs heat from the condenser and which is cooled by evaporation into the air stream, keeping the spray water at a point considerably below the outdoor dry bulb temperature. As a result, the heat transfer from the refrigerating medium inside the condenser to the water is controlled entirely by the wet bulb temperature of the air entering the condenser. Water is continuously recirculated, the only new supply being that required to make up for evaporation, and which is usually only about ten per cent of that which would be required to cool the condenser coil directly.

Casing is of 12 and 14 gauge heavy metal braced and reinforced with angle irons which are arc welded into a solid framework. Two coats of corrosion resisting paint are applied to the unit for indoor installation, and units for outdoors are further weatherproofed. Standard evaporator coils are used for the condenser coil, and are constructed of ¾ in. O. D. copper tubing with a wall thickness of 0.035 or 0.049 in.; extended surface fins are 0.012 in. copper for general use. For special applications, such as ammonia cooling, fins and tubing are of steel construction, and the complete coil is hot dipped galvanized.

Nine sizes of the unit are available with approximate capacities in tons ranging from 7.5 to 46, at 75 F wet bulb and 105 F cond. temperature.—The Trane Co., 303 S. 11th St., La Crosse, Wis.

Pumps for Low Heads

No. 682—Axial flow pump is designed to operate at high efficiency under low head conditions at speeds such as to eliminate the use of costly low speed prime movers. Differing from the regulation centrifugal pump, the axial flow pump consists simply of a pump casing in the shape of a tube and forming a part of the water passage. In this casing is a propeller somewhat similar to the propeller of a ship; its rotation forces the water through the piping system. Pumps can be arranged for various types of mounting. Circulation of condenser water, irrigation and water tunnel work are among the services to which the pump is applicable.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Stoker and Oil Burner Controls

No. 683—New "Hold Fire" time controls are designed to meet the demand for a dependable hold fire timer for automatic stokers and for periodic firing of oil burners using heavy oil, to insure fluidity. A simple knob and pointer setting arrangement with an etched dial enables setting any operating schedule from zero to 12 minutes out of each 30 minutes or from zero to 25 minutes out of each hour. Generally used with thermostats or pressure controls, if the periodic firing period occurs when the other controls are calling for heat, the timer will skip an operating cycle.

The synchronous motor employed is self starting and self

Before You Specify or Purchase Pipe Hangers, Pipe Clamps and Clips

SEND FOR THIS *Money-Saving Catalog*

THIS NEW CATALOG of Globe Pressed Steel Installation Supplies is of special interest to everyone installing Plumbing, Heating, Air Conditioning and Sprinkler Systems. Globe Parts insure greater strength, durability, lighter weight and better appearance at LOWER COSTS than many others designed for the same uses. All Globe Parts are approved by the National Board of Fire Underwriters.

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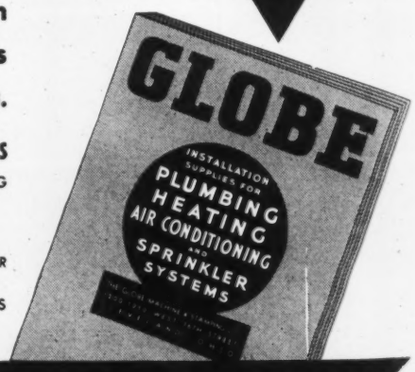
PIPE HANGERS
ADJUSTABLE SWIVEL HANGERS
SPLIT RING (CLEVIS) HANGERS
I BEAM CLAMPS
RETAINING CLIPS
UNDERGROUND HANGER CLAMPS
STEEL PIPE CLIPS
STEEL FLOOR AND CEILING PLATES
CEILING BUTTONS
STEEL INSERTS
ESCUTCHEON PLATES FOR SPRINKLER HEADS
SPRINKLER HEAD CABINETS
ADJUSTABLE CLIP BASES



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Jointite
TRADE MARK
CORK INSULATION
FOR AIR CONDITIONING

The new $1,250,000 *Loveman, Joseph & Loeb Department Store in Birmingham, Ala. All cork insulation for the air conditioning of this building was supplied and installed by Mundet.*

It was in keeping with the careful planning of this building that "Jointite" Cork Insulation was selected for the air conditioning units.

"Jointite" is made exclusively by Mundet, from 100% pure Corkwood selected by our organization in Portugal where the cork is grown. It does not wear out, settle, rot or warp, but continues its highly efficient service year after year.

For air conditioning requirements, "Jointite" offers the high quality and low transmission coefficient that have maintained universal acceptance for Mundet Cork Insulation in other fields. Write for Catalog and specification data.

We recommend Mundet Natural Cork Isolation Mats for the restriction of machine vibration. Information on request.

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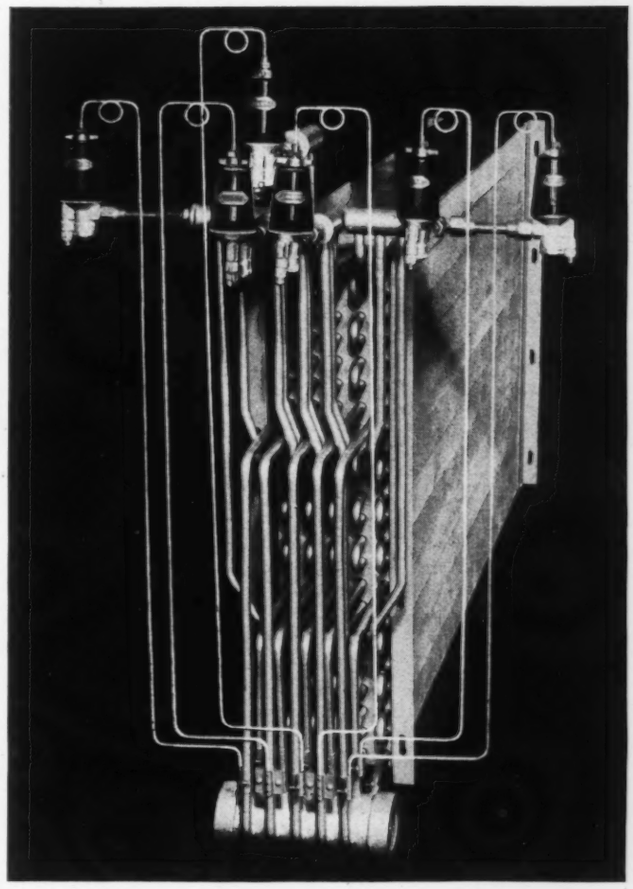

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COPPER FINS AND TUBES
MANIFOLDED AT FACTORY
ALL JOINTS WELDED
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FEDDERS
Air Conditioning
SURFACE

The air conditioning industry is using Fedders surface with outstanding success for all types of installations ranging from small, single rooms up to large banks and theaters requiring high I. M. E. tonnage. Write for Bulletin 91-A.

FEDDERS MFG. CO.
57 Tonawanda St., Buffalo, N. Y.

lubricating, and is available for 50 or 60 cycles, 115 or 230 volts a-c. Heavy silver button contactor switch is approved for 15 amperes at the lower voltage, 8 amperes at the higher. Will handle a-c motors up to 1 hp directly. Pressed steel case is 6⅞ in. high, 4¾ in. wide, and 3½ in. deep and is finished in black crackle lacquer. Three models, to meet various service conditions, are offered.—Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.

Pipe Machine

No. 684—New "Model A Special" pipe machine will cut, thread, ream and chamfer all sizes of pipe from ⅛ to 2 in.; will operate geared tools to cut and thread 2½ to 12 in. pipe; will cut off solid round bars or stay rods ¼ to 1 in.; and will thread bolts and stay rods from ¼ to 2 in.—Beaver Pipe Tools, Inc., 310 Dana, N.E., Warren, Ohio.

The Editor's Correspondence

Temperatures and Humidities for Tobacco Fermentation

THE EDITOR—Can you furnish me with information on the proper air conditions for tobacco fermentation? Specifications on a job with which I am concerned call for temperatures between 15 and 40 C and relative humidities from 5 to 90 per cent?—A. B., ENGINEER.

REPLY—It is not difficult to set up the particular conditions required for any given lot of tobacco but it would be almost impossible to lay down a general set of rules for work with all the various types of tobacco which are used today. Cigarette and pipe tobaccos, for instance, are given a totally different treatment from that used for cigar work. Furthermore, each manufacturer or tobacco handler has a rather well defined set of pet notions about how to treat his material and is, in most cases, extremely reluctant to pass this information on.

In general, however, the specifications given above, *i. e.*, temperatures of from 15 C to 40 C and humidities from 5 to 90 per cent, are entirely too broad. In our experience, we have found that fermentation proceeds best between temperatures of 25 C to 50 C and the proper relative humidities are from 55 to 85 per cent. Under the 55 per cent level, it is impossible to retain enough moisture in the leaf to permit of any fermentation action and over the 85 per cent level one encounters danger from mold.—RUSH D. TOUTON.*

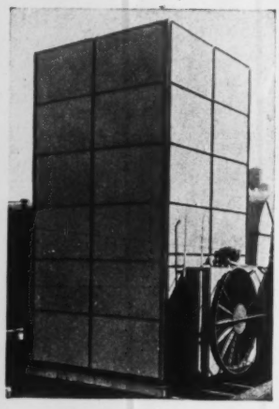
*Technical Director, Bayuk Cigars, Inc., Philadelphia, Pa.

Booklets, Reports and Papers

Economics of Indirect Water Heating

The Committee of Ten—Coal and Heating Industries, 307 N. Michigan Ave., Chicago, Ill., has recently issued a 6 page mimeographed report on "The Economics of Heating Water with the Indirect System and Coal," by R. E. Moore, Vice-President, Bell & Gossett Co. Copies are available from the Committee for 5c.

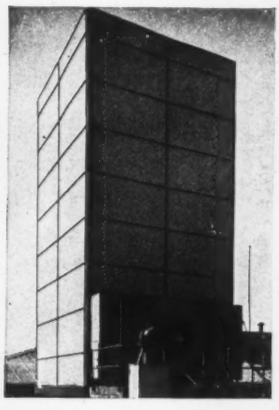
The economies that are possible are pointed out, and it is stated that the real savings come in where it is possible through the use of a pump to reduce the size of the indirect heater by as much as 33 per cent. Labor in pipe and material costs are in some cases reduced as much as 80 per cent. It is pointed out that one-third of the coal used by a building is for heating domestic service water. Examples are given of savings made in apartments and office buildings.



More Popular

because they are

More Practical



Marley forced draft towers lead in simplified construction—in spray distribution — in quiet operation—in other innovations that make them the most practical forced draft towers for today's requirements.

We will be pleased to supply anyone, anywhere, with full information upon request.

THE MARLEY COMPANY, 1915 Walnut, Kansas City, Missouri

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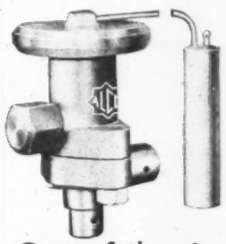
FORCED DRAFT COOLING TOWERS

SERIES "T" THERMO VALVES

For Liquid Refrigerant Control

6 TYPES OF VALVES

13 CONSTRUCTION SIZES



One of the six

- Covering all capacity requirements from fractional tonnage to 29 tons Methyl Chloride or 16 tons Freon per hour.
- The simplest valves ever produced — only three pieces. The only installation tools required are an open end wrench and a screwdriver.
- The sturdiest valves ever produced. 800 pounds pressure will not rupture the power element. After 3,000,000 flexings no signs of deterioration can be detected. Alco Series "T" Thermo Valves are as sturdy as the strongest part of the refrigerating system.
- Responsive to the slightest change in superheat, yet adjustable to control at any required superheat up to 24° F.
- Built for the performance you have a right to expect—and guaranteed to do it.

For further details ask for Bulletin 144C

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ST. LOUIS, MO., U. S. A.

New York Chicago Los Angeles San Francisco

CORINCO

Cork Pipe Covering Fits *SNUGLY*

Cold Line Insulation cannot be effective unless the insulation material fits snugly. The smallest air space between the pipes and covering will collect moisture which in turn forms ice and thus impairs the efficiency of the entire installation.

SPECIFICATION OF CORINCO CORK PIPE COVERING IS ASSURANCE FOR MAXIMUM EFFICIENCY AND MINIMUM MAINTENANCE

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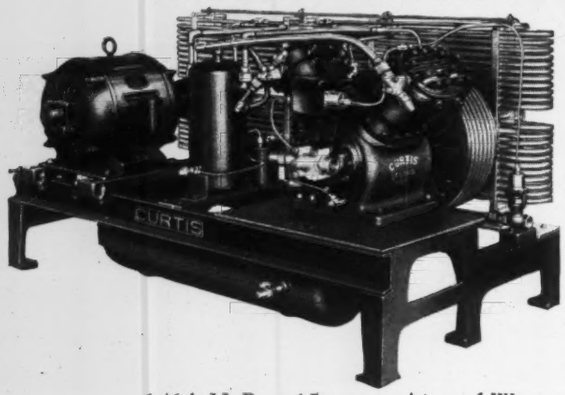

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Advanced design, soundly engineered. 82 successful years—financial stability.

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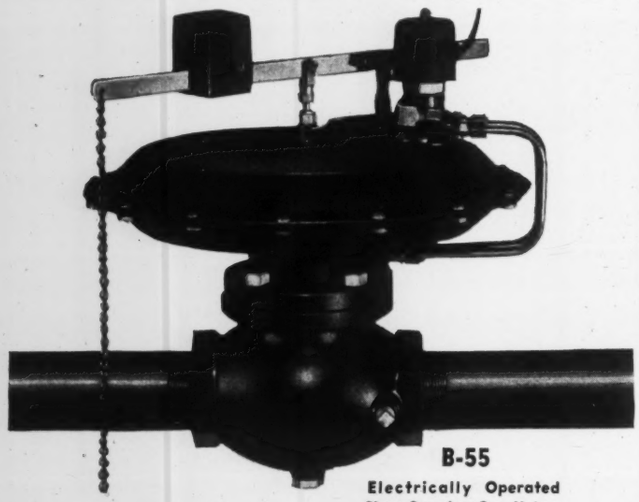

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Electrically Operated Slow-Opening Gas Valve

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The GENERAL B-55 slow-opening gas valve provides simultaneous control of gas flow and damper opening for industrial boilers and furnaces. It allows a flare-pilot effect for ignition of the main flow of gas—slowly opens louvre door slightly ahead of gas flow—delivers a uniform increase of flow to burners. Industrial users enthusiastic over field performance. For engineering data and wiring diagrams write for catalog M-182.

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Air Hygiene Foundation

Information Circular No. 1 of the Air Hygiene Foundation of America, Inc., Thackeray Ave. and O'Hara St., Pittsburgh, Pa., explains its object and regulations. Purposes of this organization, as outlined by H. B. Meller, Managing Director, are to conduct investigations of and stimulate research on problems in the field of air hygiene, and to gather and disseminate factual information relating thereto. An investigation under support of the Foundation has been begun at Mellon Institute of Industrial Research, Pittsburgh, in which the hygienic, technologic and economic aspects of air contamination, especially by dust in industries, will be studied.

Conventions and Expositions

Air Conditioning and Heating Conference: March 25-27, Iowa State College, Ames, Ia.

Southern Industrial Show: April 6-11, Textile Hall, Greenville, S. C. Wm. G. Sirrine, President.

National Oil Burner Show: April 14-18, Convention Hall, Detroit, Mich. Managing Director, G. Harvey Porter, Oil Burner Institute, Inc., 30 Rockefeller Plaza, New York, N. Y.

Midwest Power Show: April 20-24, International Amphitheatre, Chicago, Ill. Management, Midwest Engineering & Power Exposition, 308 W. Washington St., Chicago, Ill.

Midwest Power Engineering Conference: April 20-24, Palmer House, Chicago, Ill. Secretary G. E. Pfisterer, 308 W. Washington St., Chicago, Ill.

Conference on Solid Fuels and Stokers: April 21-23, College of Engineering, University of Wisconsin, Madison, Wis. Chairman, Prof. L. A. Wilson, Mechanical Engineering Building.

Air Conditioning Conference: May 4-5, College of Engineering, University of Illinois, Urbana, Ill.

Heating, Piping and Air Conditioning Contractors National Association: Annual convention, May 25-27, The Bellevue-Stratford, Philadelphia, Pa. Educational Director, S. Lewis Land, 1250 Sixth Ave., New York, N. Y.

National District Heating Association: Convention and exhibit, June 16-19, Pantlind Hotel, Grand Rapids, Mich. Acting Secretary, Miss M. C. Stocker, 124 W. Fourth St., Greenville, Ohio.

National Warm Air Heating and Air Conditioning Association: Convention, June 17-18, Deshler-Wallick Hotel, Columbus, Ohio. Manager Director, A. W. Williams, 50 W. Broad St., Columbus, Ohio.

International Congress of Refrigeration: June 16-27, The Hague and Amsterdam, Holland. Organization Office, 107 Stolberglaan, The Hague (Holland).

American Society of Heating and Ventilating Engineers: Joint semi-annual meeting with *American Society of Refrigerating Engineers*, June 22-24, Buck Hill Falls, Pa. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

Short Course in Coal Utilization: June 9-11, University of Illinois, Urbana, Ill. A. C. Callen, Head of the Department of Mining and Metallurgical Engineering, 209 Transportation Bldg., Urbana, Ill.

American Society for Testing Materials: Annual meeting, June 29-July 3, Chalfonte-Haddon Hall, Atlantic City, N. J. Assistant Secretary, R. E. Hess, 260 S. Broad St., Philadelphia, Pa.

Great Lakes Exposition: July-September, Exposition Hall, Cleveland, Ohio. General Chairman, Dudley S. Blossom, Terminal Tower, Cleveland, Ohio.

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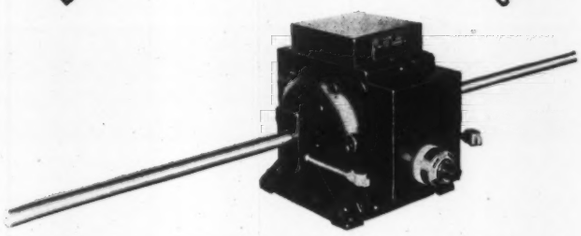

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HERE'S WHY
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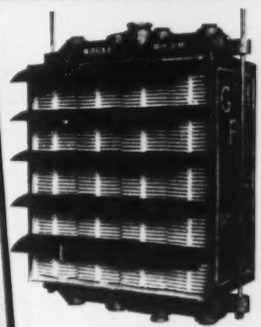

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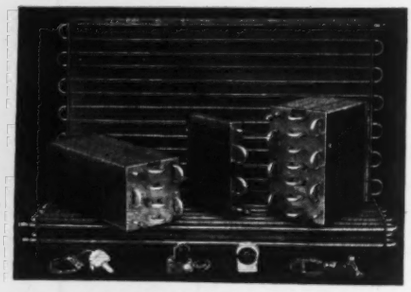

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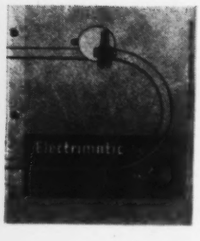

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Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 119

No. 901. AIR CONDITIONERS: De La Vergne Engine Co., Philadelphia, Pa. 4 p. bulletin describing self-contained air conditioners for summer and winter air conditioning which operate on the reverse refrigeration principle. Principle is explained and specifications and a diagram are given.

No. 902. AIR CONDITIONING: Standard Air Conditioning, Inc., 40 W. 40th St., New York, N. Y. 12 p. bulletin entitled "A Common Sense View of Air Conditioning," describing room cooling units and their applications, the meaning of winter air conditioning and year around air conditioning, and features of the equipment for meeting these requirements. Also, 16 p. booklet on "S. A. C." cabinet type humidifiers, describing various models; 8 p. booklet on filtering dust and pollen, describing window filter and ventilator units; and 12 p. booklet on reducing noise by means of window ventilator, filter and noise eliminating units.

No. 903. ALLOYS: Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y. Issue of "The Moly Matrix" (Vol. 2, No. 7) featuring an article on use of carbon-molybdenum steel in valves because of its high creep strength.

No. 904. BOILERS: Fitzgibbons Boiler Co., Inc., 570 Seventh Ave., New York, N. Y. 8 p. bulletin on stoker fired steel boilers for heating and hot water service, "R-Z-U Junior" in ratings from 750 to 3900 sq ft and "High Furnace R-Z-U" ratings 2190 to 42,500 sq ft, with description of features and dimension and rating tables. Also, 8 p. bulletin on steel boilers for hand-fired coal, oil, gas or stoker firing for heating and hot water service in small apartments, institutional and business buildings, describing features, giving rating tables and showing typical installations.

No. 905. COMPRESSORS: Frick Co., Waynesboro, Pa. 16 p. bulletin on enclosed type "Freon" compressors, describing construction of the machines in detail, showing a number of installations for air conditioning and giving specifications.

No. 906. CONTROL: Johnson Service Co., 507 E. Michigan St., Milwaukee, Wis. 24 p. condensed catalog of automatic temperature and humidity control for heating, cooling, ventilating, air conditioning and industrial processes, including discussions and photo-diagrams showing application of control to various types of installations, discussing recent developments in air conditioning and temperature control, and illustrating and describing numerous instruments.

No. 907. DRIVES: Allis-Chalmers Mfg. Co., Milwaukee, Wis. 12 p. bulletin on "Vari-Pitch Texrope" sheaves for variable speed V-belt drives, both stationary controlled and motion controlled types, including general dimension tables covering a large number of sizes for numerous applications.

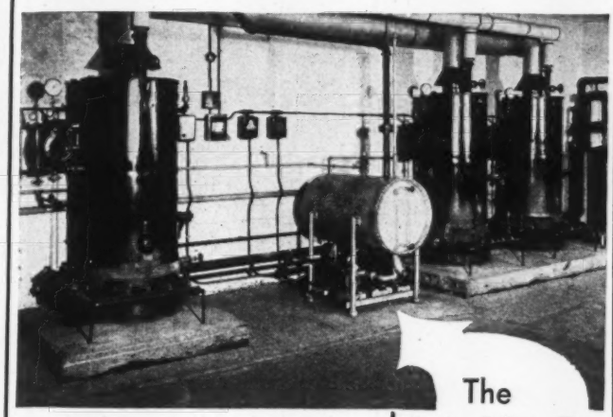
No. 908. DRIVES: Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. 32 p. booklet on "Silverstreak" silent chain drives, available from stock from ½ to 60 hp, including description of details, instructions for selecting drives, list prices, and horsepower and ratio tables.

No. 909. FITTINGS: Thomas Devlin Mfg. Co., Inc., Burlington, N. J. 36 p. catalog covering full line of malleable, cast iron, and brass fittings, unions and flanges with complete list prices and size tables. Also, 4 p. supplement on "Fretz" nipples.

No. 910. EROSION: The Debevoise Co., 968-978 Grand St., Brooklyn, N. Y. 12 p. booklet on erosion of condenser tubes and the prevention of erosion from water in motion by "Debecote," a paint-like material. Information is given on improvement of tube life due to painting inlet ends, heat transfer, use in connection with a mercury boiler installation, protecting condenser circulating pump impellers, and the preparation and coating of parts to be protected, including condensers, pump impellers and interior of piping.

No. 911. EVAPORATIVE CONDENSERS: The Trane Co., 303 S. 11th St., La Crosse, Wis. 4 p. bulletin describing

LESS FUEL LABOR WASTED TIME



This unit *automatically* maintains a constant water level in high or low pressure boilers...pumps feed water against the boiler pressure...returns condensate to boiler...supplies make-up water as needed.

Operated electrically...it can be used with gas, oil, stoker or hand-fired boilers.

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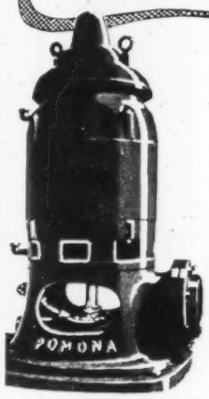

"We like the POMONA because we do not have to pull it up for repairs, or other troubles, and have no repair expense."

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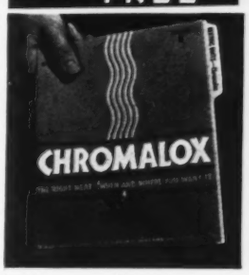

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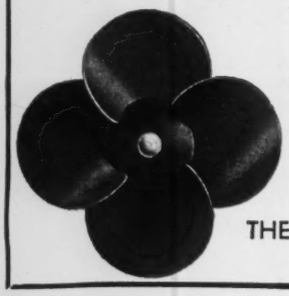

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evaporative condensers for reducing water and power costs on refrigerating and air conditioning installations, including description of the equipment, construction details and dimension and capacity table. A 16 p. supplement gives technical data, pressure drop curves and other information.

No. 912. FILTERS: Consolidated Air Conditioning Corp., 192 Lexington Ave., New York, N. Y. Loose-leaf booklet on activated coconut shell carbon odor filters and their applications in filtering and air conditioning systems, industrial exhaust systems and special systems. Properties of the carbon used are discussed, information on service life is given and diagrams of a number of arrangements of the equipment are presented.

No. 913. FLAT ROLLED STEEL: Youngstown Sheet & Tube Co., 602 Stambaugh Bldg., Youngstown, O. 16 p. booklet giving a complete description of modern continuous mill operations for the production of sheet and strip steel, including numerous illustrations.

No. 914. HEATING SURFACE: John J. Nesbitt, Inc., State Rd. & Rhawn St., Holmesburg, Philadelphia, Pa. 40 p. catalog of heating surface with steam distributing tubes for uniform steam distribution in blast heating surface to meet the needs of automatic temperature control. Part 1 gives complete explanation of the surface, its features and construction and Part 2 is devoted to application, including control, resistance to air flow, selection, capacity tables, piping notes and diagrams, specifications, etc. Numerous diagrams are included.

No. 915. PUMPS: Worthington Pump & Machinery Corp., Harrison, N. J. Series of bulletins on internal roller bearing, double helical rotary pumps for heavy duty, continuous service; internal sleeve bearing, double helical rotary pumps; external ball bearing, double helical rotary pumps; and horizontal duplex piston pumps for general service, giving description of construction, specifications, sizes and displacements.

No. 916. REGISTERS: The Auer Register Co., 3608 Payne Ave., Cleveland, O. 40 p. catalog of registers for air conditioning, ventilating and heating systems, available in many types with descriptions, illustrations and list prices.

No. 917. REGISTERS AND GRILLES: Hart & Cooley Mfg. Co., 61 W. Kinzie St., Chicago, Ill. 36 p. catalog of air conditioning registers and grilles, describing installation and construction details and giving technical information. A section is devoted to the problem of air distribution, and includes a number of charts of air distribution.

No. 918. SMOKE DENSITY RECORDERS: Leeds & Northrup Co., 4952 Stenton Ave., Philadelphia, Pa. 16 p. bulletin devoted to "Micromax" smoke density recorders (indicating, signalling and recording), describing importance of such equipment in boiler plant operation, the principle of operation, and illustrating the equipment.

No. 919. STEEL: The American Rolling Mill Co., 703 Curtis St., Middletown, O. 4 p. bulletin of useful facts about "Armco H. T.-50" a special high tensile steel. Available in standard finishes of plates, hot rolled, hot rolled annealed sheets and strip, and cold rolled sheets and strip.

No. 920. TEMPERATURE MEASUREMENT AND CONTROL: Taylor Instrument Companies, 95 Ames St., Rochester, N. Y. Leaflet describing "thermospeed" well tube systems developed to improve the rate of response of industrial temperature measurement and control instruments.

No. 921. TUBE FABRICATING EQUIPMENT: Parker Appliance Co., 17325 Euclid Ave., Cleveland, O. 24 p. bulletin of instructions and price list for a complete line of tube fabricating equipment, giving detailed descriptions and instructions for use.

No. 922. UNIT HEATERS: L. J. Wing Mfg. Co., 14th St. & 7th Ave., New York, N. Y. Data sheet on high velocity unit heaters for preventing entrance of cold air at shipping department and garage doors, describing the problem, showing how it may be solved, and giving capacity data. Also, 2 p. bulletin devoted to heating a garage by the "Floodlight" principle with

unit heaters, with information on fuel saving, capacity data and showing method of installations.

No. 923. VALVES: The Edward Valve & Mfg. Co., Inc., 1200 W. 145th St., East Chicago, Ind. Complete catalog of some 240 pages devoted to non-return valves, cast steel valves, blow-off valves, forged steel valves, atmospheric relief, back-pressure and bleeder line non-return valves, and "ferac" (high strength iron) valves.

No. 924. VALVES: Hancock Valve Division, Consolidated Ashcroft Hancock Co., Inc., 11 Elias St., Bridgeport, Conn. Leaflet describing union bonnet bronze valves with hardened stainless steel trim for steam, giving list prices.

No. 925. VALVES: Haynes Stellite Co., 205 E. 42nd St., New York, N. Y. 8 p. booklet on "Stellited" valves for high temperature, high pressure steam service, describing how freedom from wire drawing, galling or seizing, and corrosion is obtained by hard facing steam valves with cobalt-chromium-tungsten alloy. Typical results are reported and the method of hard facing valves is described.

No. 926. WELDING: Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y. 32 p. catalog of "Airco" electric welding products, including 39 types of welding rods, supplies and "Wilson" electric welding machines. A technical data section includes tables of recommended voltages and amperages, weight of rods, a summary of the cause of bad welds, and other information.

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672	673	674	675	676	677	678	679	680
681	682	683	684	685	901	902	903	904
905	906	907	908	909	910	911	912	913
914	915	916	917	918	919	920	921	922
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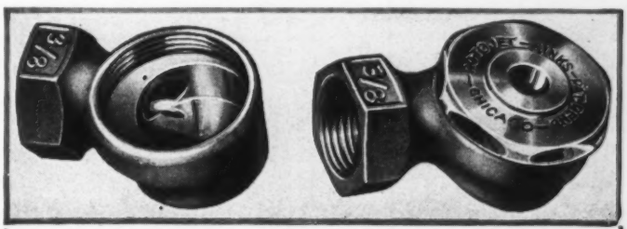

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TITUSVILLE, PA.

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